Spatial Relations in Congenitally Blind Infants

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Preface

Knowledge of spatial relations is an important part of the infant's development, as such knowledge enables the infant to gather information about the external world. The congenitally blind infant has, however, difficulty in developing early spatial relations.

In 1980 I designed some experimental material to try and help blind, mentally retarded children achieve understanding of spatial relations. The material called "The little Room" is composed of pipes and panels, and equipped with several objects it stimulates activity and development in even the most passive and profoundly mentally retarded, blind children.

In co-operation with *Handikappinstitutet,* Sweden and *Kopparbergs läns landsting,* Sweden a prototype was made and since 1984 "The little Room" has been produced in the workshop LH-verkstan, Hedemora, Sweden.

In August 1983 the *Danish Medical Research Council* and the *Danish Research Council for the Humanities* arranged a symposium to promote scientific investigations into the problems of the development and life of disabled people. At this symposium I exhibited "The little Room" and talked about the problem of development of spatial relations in blind children suggesting that the effect of "The little Room" should be investigated in respect to the development of spatial relations in congenitally blind infants.

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Statistical analysis was performed by cand.psych. *Tytte Hetmar* and cand.psych. *Jan Rattleff.*

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But not least I want to thank the parents, who so willingly agreed to let me video record their babies. It has been interesting and exciting to observe how congenitally blind infants learned about spatial relations in "The little Room", and it has been of great joy to see the facial expressions of the infants during this process of learning.

Finally, I want to thank *Fran Theakston* for her help in correcting my English.

Introduction

Chapter 1

From the very first day of life the congenitally blind infant is severely restricted in his ability to gather information about the external world. Within the first few weeks of life sighted infants begin to relate to objects and events with their sounds which come from the "outside" (Aronson & Rosenbloom, 1971; Bower, 1977; Wertheimer, 1961; Warren, 1974). The blind infant is unable to understand the relation between sounds and objects, even tactile contact with objects gives him only very fragmentary information about their qualities. When touching or pushing an object he will experience no relation between that particular object and others. When he has learned to grasp and let go of, for example a rattle, he is unaware that the sound of the rattle dropping is related to his own action. He also has problems controlling his own movements and using both hands in a co-ordinated fashion (Best, 1986; Tobin, 1980).

Thus, lack of vision means that much information about the external world is unavailable, and the infant therefore lacks a basis for exploration and experiments which would provide an awareness of spatial relations. Some authors have suggested that sighted and blind infants have a similar development during the first three months of life (Sandler, 1965; Burlingham, 1961); this statement has also been outlined in several guides for parents. However, from the very first day of life the possibilities for development and learning are effected by the lack of vision (Adelson & Fraiberg, 1974; Burlingham, 1972; Davidson & Simmons, 1984; Fraiberg & Freedman, 1964; Fraiberg, 1977, Hartlage, 1969; Hunter, 1964; Jan et al., 1983; Norris, Spaulding & Brodie, 1958; Wills, 1970; Warren, 1984).

The aim of the present study is to investigate whether a specially designed experimental environment would facilitate the development of early spatial relations and to observe which properties of this environment would improve the development of

spatial relations very early in the life of the congenitally blind infant. The intention is not to deal with all the many aspects of motor, social, emotional, perceptual and cognitive development or the important interaction between the infant and the parents or other caregivers. These areas will only be touched on briefly when connected with spatial relations in the congenitally blind infants. The intention is only to observe if congenitally blind infants can possibly be given an early basis for awareness of spatial relations when exposed to a specific experimental environment.

In this work congenitally blind refers to those who have been totally blind, or who have had no more than a perception of light from birth. Infant refers to the first 2 years of life, and child refers to those more than 2 years of age.

The term spatial relations refers to those connections between the blind infant and the external world that he is able to perceive by using his kinesthetic, auditory and tactile modalities; this involves the position of objects in relation to each other, to the child and to the field around him – experiences which may provide him with a spatial framework.

Spatially Related Activities in Sighted and Blind Infants

1.1 A review of the literature about spatial relations in blind chilren shows a remarkable difference between blind and sighted children in their ability to solve spatial tasks. Hunter (1964) compared 12 blind with 12 sighted 12-18 years old students for this ability. The conclusion was that congenital blindness is associated with subtle but significant impairment. The blind seemed habitually to underestimate space – both small dimensions and large distances. Hunter also stated that congenitally blind students probably require more training in the manipulation of objects to aquire the same degree of proficiency as the sighted.

Hartlage (1969) studied 10 blind and 10 sighted students to determine whether sight was necessary in dealing with spatial questions. The result was that the blind students were significantly poorer at performing the spatial tasks than the sighted students, whereas the students did not differ from sighted in tasks not involving spatial relations. In 1976 Hartlage repeated the study with 110 blind and 110 sighted students and got the same result.

He concluded that lack of sight must be an important if not critical factor in the ability to deal with spatial problems.

Warren (1984) calls attention to the lack of studies about the developmental process of achieving spatial concepts in blind children, and he is critical towards the many studies of comparing blind and sighted children, arguing that much of the time and energy used for such comparisons should rather be used as intensive studies comparing blind with blind. I agree with these statements. Our knowledge about the nature of blindness needs to be extended so that developmental delays in particularly congenitally blind children may be reduced. However, comparisons of blind and sighted children may be useful if, besides the conclusion of the general developmental delay in blind children, they point to those areas of development that are most critical for the blind. Maybe such knowledge would enable us to find solutions in providing blind infants with optimal learning possibilities.

It is notable that nearly all studies about spatial relations in blind children, both those which compare blind with sighted and the few which deal with blind children only, conclude that lack of knowledge about spatial relations in blind children must be due to lack of very early experience. Despite the fact that this conclusion has been repeated many times for many years, the review of the literature shows, that we still know very little about the congenitally blind infant's ability in mastering spatial relations.

Hill (1970) made a study with 30 congenitally blind 7-9 years old children. Fifteen of the children participated in a formalized programme about the understanding of concepts of position. The aim was to study whether participation in such a program would give the children better understanding of the terms of position. From the results it could be seen that the experimental group showed a big difference between pre-test and post-test scores compared with the control group. Hill quoted the statement of Hapeman (1967): "congenitally blind children tend to lack the necessary concrete knowledge of their environment and the necessary basic concepts of distance, direction and environmental changes".

However, achieving a concrete knowledge about concepts of position must be something which even congenitally blind children are able to learn much earlier in life than at the age of 7-9 years and if they achieve these abilities early in life it seems likely

that it will be of extreme importance to their ability in solving different tasks within the field of spatial relations.

According to Piaget (1954) the understanding of the reality of the world involves experience of time, quality, quantity, space and causality. Without knowledge about each of these fields the human being is unable to integrate himself to the outside world and to understand himself as a part of it. He must learn about the external world if he is to succeed in developing self-identity. During infancy he must begin to perceive himself as the one who affects his surroundings, otherwise he is unable to make decisions with experimenting and exploring activities, learning more and more about the reality of the world.

How different is the congenitally blind infant's opportunity to achieve knowledge about the reality of the world compared with that of the sighted infant?

Experiences of Time in Sighted and Blind Infants

The Sighted Infant.

1.1.1 Within the first weeks of life the sighted infant can be observed relating time with acitivities (Piaget 1954). He sucks for a short or a long time, with short or long intervals in between, and he looks at objects or individuals for different lengths of time. As early as the second month sound from an object encourages the infant to search the object visually and thus develop the expectation that sound has a source which can be visually localized and looked at for varying lengths of time. Gradually he learns about the relation between objects and the extent of sounds that come from them.

When the infant has learnt to visually follow a moving object he discovers that it is visible for varying durations. While looking at a stationary object for a long time he discovers that he sees such objects more clearly than when looking at them for a short time and he learns that he can repeat the action whenever he wants – with varying intervals in between.

Soon he is able to indicate that he is no longer interested in looking at a stimulating object. He decides for how long time he wants to be stimulated and initially this is done without closing his eyes or turning his head, he merely looks straight through the presented objects or the indvidual.

Later on the infant learns that closing his eyes or turning his head means that the adult immediately respects his need for intervals of relaxation between periods of stimulation. Usually it is easy for the adult to interpret that certain attitudes of the sighted infant means that he is no longer interested. When the sighted infant is able to hold a rattle for a while, he will shake the rattle for a long or short time. Having let go of the rattle he is able to look for it, controlling its position and grasping it whenever he wants. He experiments with sequences of temporal activities involving visual, motor and auditory performance. Early temporal experience becomes a part of his scheme to be used for further learning about the reality of the world.

The Congenitally Blind Infant.

The congenitally blind infant also sucks for short or long periods with varying intervals, but in many other temporal acitivities the absence of vision affects his learning about time.

Fraiberg (1979) reported that blind infants within the first 2 months of life turn their head towards an emerging sound and that this reaction then disappears only to emerge again as late as at the age of 8 to 10 months or even later.

In my opinion blind infants stop turning their head towards a sound because they are unable to relate the auditory experience to any other sense modality. This disability also makes it difficult to distinguish object-based sounds from each other. Therfore, often the blind infant does not know that sounds from a rattle being shaken by an adult, are supposed to stimulate him; it is even unknown to him that the emerging sound comes from the rattle. In traditional surroundings the blind infant perceives sounds as something which happens accidentally. Sounds and their duration are experienced without perception of the source and without any relation to motor performance of the infant. This means that the blind infant misses both visual and auditory modalities as means for early temporal activities. He may be observed shaking a rattle for varying lengths of time. However, having shaken and let go of a rattle he is unable to know that the rattle still exists and be able to control its position. He is incapable of grasping the rattle and repeating the activity by himself at the moment chosen by him.

Fraiberg (1977) mentioned the lack of facial expression in the blind infant and stated that the absence of eye contact gives the negative sign of "no interest". As the signs from the blind infant are difficult to interpret it can be difficult to verify whether or not the blind infant wants to be stimulated. This situation is very confusing for the adult and establishes an uncertainty which can lead to diminished contact and interaction between the infant and the adult. The result can be that the blind infant is not stimulated when he wants to be, or that the stimulation continues when he wants a break. When the infant receives inappropriate responses to the signs he is giving, there is a risk that he misses the opportunity to initiate activities and social relationships. Too many wrong or missing responses on initiatives from the blind infant may disturb not only his social development but also his early learning about time, as well as other elements of the reality of the world.

Thus, compared with the sighted infant the blind infant's experience of temporal activities is very limited and his scheme for further learning about the reality of the world must be quite different from that of the sighted infant.

Experiences of Quality in Sighted and Blind Infants

The Sighted Infant.

1.1.2 By playing and experimenting with time, sighted infants have already included some experience about different qualities of movements, sounds and visual impressions (Piaget, 1954).

They play with their hands, spread their fingers, wave and grasp their own hands and examine them closely. The midline organization of hands enables them to move objects from hand to hand and to turn objects around while looking at them. This integration of visual and kinesthetic performance encourages them to perform more and more qualified movements, including pushing, touching and grasping objects. They also learn to use grades of muscle strength and to rotate their hand.

Each time the sighted infant moves his body to another position his visual ability provides him with new information about qualities of the outside world. He is also selective about visual and auditory experiences. During the first month of life he prefers to look at high-contrast, geometrically contoured patterns and in

the second month of life he prefers to look at rounded, complex patterns (Hyvärinen & Lindstedt, 1981). During the first months of life he displays a preference for specific sounds, as for example the voice of the mother and rattles with low frequency sounds, later on he prefers high frequency sounds (Schaffer, 1977).

Having pushed an object so that it is out of reach he looks for another object to push, learning that not all seen objects can be pushed. From banging his toys on surfaces around him he learns about qualities of sounds. Very early in life he can distinguish between different smells and tastes and when getting more varied food he also learns about their different qualities.

While playing with toys as well as observing his surroundings, he compares qualities such as light and darkness, smooth and rough, heavy and light, different colours, sounds and movements, and he combines his experiences by playing sequence-games.

When habituated with an activity his looking around encourages him to perform another activity. He reacts with disappointment if he has nothing to do. He begins to identify himself as being an active exploring individual.

Each time he learns about a new quality this will be a part of his scheme for further development, and proportionately, the more he experiences the complexity of the world the more he is able to understand and to accept changes of this world and be curious about it.

The Congenitally Blind Infant.

Although the congenitally blind infant achieves some experience about qualities from his movements and listening as well as from touching, smelling and tasting, these experiences are very limited compared with that of the sighted infant.

Fraiberg (1977) and others (Bower, 1977; Burlingham, 1972; Davidson et al., 1984; Elonen et al., 1964; Warren, 1984) mention the general motor passivity in blind infants. In my opinion this passivity is a result of poor integration of the kinesthetic sense with other sense modalities.

Although, during the first two months of life the blind infant moves his hands and fingers, this performance can only be integrated with tactile experiences. However, the tactile experiences available are limited to those from his own body, clothes and bedclothes. When touching an adult he experiences the same

kind of tactile qualities. Usually a sweep of the hand only brings him into contact with empty space. Random movements do not bring him into contact with objects in his surroundings sufficiently enough to encourage him to perform further movements. The few things he encounters accidentally or those which are passed in to his hands do not encourage him to make new movements. In this way he misses the experience of further tactile qualities. When he has become habituated to touch himself and his clothes he places his hands next to his head. He misses the development of midline organization of hands and he misses the development of muscle strength in arms, hands and fingers. The result is weak hands and undeveloped patterns of movements which later on makes it difficult for him to move objects from hand to hand, to use his hands simultaneously and to perform rotation of the hand.

As the blind infant is unwilling to put objects to his mouth to suck them and later on to bite them, he misses the experience of different qualities of tastes, smells and shapes. Consequently he is unable to integrate such sensory experiences to the kinesthetic and tactile sense modalities.

Alin-Åkerman (1982) and Scott (1968) mention that infants especially enjoy the smell of anise and peppermint. However, the traditional care for babies does not usually include surroundings with different smells, at least not in the way, that toys and other objects are offered the infant with the purpose of giving him the experience of different qualities of smell.

When the caregiver places an object in the hand of the blind infant it is immediately dropped. Even if the object is replaced in his hands many times he does not seem to be interested in anything else other than letting it go. As he is unable to use both hands simultaneously it is difficult for him to search for details of the object given to him. Mostly he has only one object at a time preventing him from being selective, comparing and distinguishing objects.

As he cannot pick up toys or does not push toys and objects he does not get enough experience about their different qualities. Also the poor development of finger movements and muscular strength hinders the gathering of knowledge about tactile qualities.

As studies have given evidence for preferential looking (Hyvärinen & Lindstedt, 1981) and preferential hearing (Schaffer, 1977)

during the first months of life it is likely that infants also prefer to touch some structures more than others. However, ignoring whether they do or not, blind infants are not consciously provided with such structures to touch.

The only sounds the blind infant is able to relate to his own activities are the sounds from his own voice and from his movements. This means, that even if the blind infant can experience different qualities of sounds from the outside world he cannot integrate these to any of his own activities. As most parents and other caregivers do not know that during the first months of life infants prefer low frequency sounds and as signs from the blind infant are difficult to interpret (Fraiberg, 1977), the blind infant's opportunity to experience qualities of preferred sounds is rare. On the contrary, parents often give the blind infant rattles with high frequency sound. Thus, the blind infant misses the reinforcement which may be involved in low frequency sounds. With traditional care he experiences an inadequate amount of qualities and achieves very little information about his surroundings. He becomes used to being passive and later on he has difficulty in identifying himself as an active exploring individual. His ability to accept changes and to be curious about his surroundings is highly negatively affected.

By the age of 2-4 months he is accustomed to the available experiences. In the sighted infant this encourages performance of other activities, in the blind infant it can easily result in passivity.

Experiences of Quantity in Sighted and Blind Infants

The Sighted Infant.

1.1.3

Very early in life the sighted infant gains experience about quantity with sucking and kicking movements, by looking at his hands and fingers and by tapping his own body or objects held in his hand.

Tapping games seem to include not only experiments with movements and sounds but also with how many times the activity is performed. While transferring toys from hand to hand and turning them around, he occasionally depending on the type of toy, discovers that it can be divided into two parts. From this the

sighted infant discovers that the object, which was just one item, has turned out to be two items and that the object is still two items, when letting them go. Of course the infant is as yet ignorant about the term "one" and "two", but from handling his toys and by looking at several objects he achieves the basis for understanding quantity. From emptying his box of toys he learns about a few and many, from eating his food he learns about little and much.

If an 8-10 months old sighted infant is given a pack of cards he can become very engaged with picking up and spreading the cards, practicing how many cards he can place into his hand. Later on he will carry out similar experiments with pencils or other stick-like materials.

When taking his first steps he experiments with one and two steps. He enjoys going up and down stairs. He can occupy himself for long periods of time by going up and down just two steps.

Gradually such early quantity-games serve as the basis for putting-together-games and for more constructive games.

Eventually all the quantity-games will not only be integrated into a knowledge about time and quality but also into all sense modalities.

The Congenitally Blind Infant.

The congenitally blind infant also gains experience about quantity with sucking. However, at just a few days old he misses a lot of the experiences about quantity which during the first months of life should have established the very first understanding of quantity. Because finger-movements are not encouraged by vision he moves his fingers to a lesser extent than the sighted infant. As mentioned in chapter 1.1.2 he soon becomes habituated to the movements and then becomes passive.

A blind infant also kicks his legs, but he is usually placed on soft foundations such as a mattress, a sofa or in the arms of an adult where he is unable to experience those important and varied results from his kicking which would challenge him to experiment with quantity.

Blind infants are seldom observed tapping their hands, on the contrary, they are most often observed with their hands placed next to their ears (Fraiberg, 1977). Their hands are inactive most

of the time. This means that later on when they are able to hold an object for more than a few seconds they are seldom inclined to use both hands simultaneously. Therefore they tend not to move objects from hand to hand or turn them around.

This means that during infancy they miss the first accidental experience of dividing an object into 2 parts. So lack of vision means, that they are unable to discover that the two parts are what previously was one item. Once they let go of the parts they are unable to discover that the toy when dropped on the floor is still in two parts.

When the blind infant is able to sit without support, he is still unaware of his surroundings and unable to pick up toys learning about few and many.

If he is given a pack of cards or a bunch of stick-like materials he is not able to play quantity-games in the same way as sighted infants. Because he is unused to moving objects from hand to hand, he does not experiment with how many items he can put into his own hand. These games are not played until much later in life. He simply does not pay very much attention to quantity-games during infancy.

As he is usually unable to feed himself until much later than sighted infants, eating is not an activity through which he can learn about quantity. Eventually he will begin to empty his box of toys but this activity does not seem to give him very much experience about quantity, at least not enough to motivate him to put things together or to play more constructive games. As blind infants are normally unable to walk without support until the age of 2 years (Fraiberg, 1977), they cannot during infancy learn about quantity by taking steps and by walking up and down stairs. Having achieved the ability to walk they are often kept away from stairs, because adults are afraid that the child would be in danger of falling down.

This survey of the blind infants opportunity to achieve some understanding about quantity shows, that this lack of under standing becomes part of the scheme to be used for further development.

Experiences of Spatial Relations in Sighted and Blind Infants

The Sighted Infant.

1.1.4 The first space experienced is the uterus. Inside that little room the foetus moves arms and legs encountering either the wall of the uterus or his own body obtaining tactile responses from his motor activities. In addition he experiences limits in how far he can stretch out and this experience is changing as the time for delivery comes nearer and nearer.

Early motor-tactile experiences.

Thus, the infant is born with the knowledge that the border of his universe can be touched and pushed and that this border has the quality of the wall of the uterus. Likewise he is born with the knowledge that he can touch himself and that he can suck his fingers.

During the first weeks of life many tactile experiences are like those experienced before the birth, as for example the bedclothes and the breast of the mother, but gradually the infant experiences that some borders are hard and do not give way.

While held in the arms of an adult, he experiences that the movements of arms and legs may result in tactile contact and that these movements can be impeded when encountering the body of the adult, likewise he experiences that movements do not always result in tactile contact.

According to Juurma (1973) several authors (Berkeley, 1709; Piaget, 1956) believe "that haptic, that is motor-tactile, experience perform the very first spatial experience, which later on are linked up with visual experience and create a spatial frame of reference".

Other authors as Revesz (1950), Bower (1974) and Juurma (1973) believe that the first spatial understanding is established from an integration of tactile and visual experience.

It is, however, important to observe the apparently great need the neonate has for tactile and motor-tactile experience. For example, when placed in the middle of his cot, it is often observed that he will move to a position very close to a corner of the cot. If replaced in the middle of the cot he very soon again moves to make tactile contact with the sides of the cot. Also the fact that the

infant squeezes an end of the eiderdown, his cap and other things, seems to show that he has a tactile need which must be met.

Maybe motor-tactile experience has a slightly higher preference than tactile-visual experience during the first months of life. However, as sighted infants are able to use their sight immediately after the birth, integration of tactile and visual experience occurs very early, so that it is difficult to distinguish which of the two cross-modalities is most important for the very first understanding of spatial relations.

Early motor-visual experiences.

The literature gives many reports of studies about sighted infants' ability to direct visually towards objects and sounds and to judge distances between objects and events (Aronson & Rosenbloom, 1971; Bower, 1965; Butterworth, 1981; Freedman, 1971; Piaget, 1954).

When 2-3 months old, the infant plays a lot with his hands. By watching his hands while moving them in various ways and in different directions the first eye-hand coordination is developed. This achievement encourages him to push and touch what he sees. When able to hold an object for a while, it is led to the mouth or to the other hand and at this stage most of the infant's activities take place within the area around the mouth and in front of the eyes. When the first eye-hand-object coordination is established he looks for the objects, he has been letting go and he begins to reach for objects, both those which are passed on to him and those which are hanging over him as well as everything which is placed within his range. When the infant's motor development enables him to locomote he moves with the aim of getting on to objects and individuals observed just outside his range.

In this way the infant achieves knowledge about the relative relationship of objects and about the spatial relation between himself and objects and individuals in his surroundings.

Furthermore, by his activities he achieves knowledge about the sensory qualities of these spatial relations – in other words, some objects can be seen and touched, but cannot be grasped and moved; some objects can be both seen, touched, grasped and moved; some objects can be heard, but not reached, some can be both heard, seen, touched and moved and so on and so on.

Early visual-auditory experiences.

When the sighted infant turns his head towards a sound he sees the source of the sound, he sees the moving mouth of the talking adult and he sees the rattle which is shaken in front of him. He hears the steps of the approaching adult and gradually he learns that emerging sounds have a source either from objects, individuals or events (Sonksen, 1979; Sonksen et al., 1984). Gradually he integrates this knowledge to his motor activities.

Early experiences of small rooms.

Inside the perambulator the infant has tactile contact not only with the eiderdown and the mattress, but also with the walls of the hood. The hood is a small room enabling the infant to experience the echoes from his sucking and babbling.

Every time the infant has clothing put over his head, he alternately experiences contrasts, such as seeing and not seeing something of the surroundings, experiencing darkness and light, differences in temperatures and intensity of sounds. Often adults reinforce these experiences by playing a peek-a-boo game placing a nappy or another piece of clothing over the head and arms of the infant. Such games give the infant a lot of experience of different spatial qualities together with the experience of interaction with the adult. Gradually the infant initiates such games by grasping a piece of clothing before the adult has finished dressing him, or the infant pulls the blanket over his head subsequently removing it. Temporal experiences is also brought into these games. This can best be described by the "not now, but now"-activities, which involve both expectation, motivation, decision, interaction with the adult and integration of all these elements to temporal and spatial experiences. The infant also wants the game repeated a few or many times and he performs different qualities of the game. From the reaction of the infant the adult learns whether the infant wants to continue with the game.

When 6-8 months old and able to turn around, the infant explores his nearest surroundings. While lying on the floor he often moves under the sofa, a chair or a low table. Here he discovers that he can make tactile contact with "the ceiling". Similar to his experience inside the hood, he hears the echoes from the sounds he is producing, either by his voice or by his activities. When finding

the infant under the sofa the adult often reacts by saying "Oh, have you got away under the sofa" whereupon the infant is pulled out in the open. However, shortly after the infant again moves under the sofa.

When able to crawl, the view of tables and chairs inspires the infant to crawl underneath them. The view of a half-open door of a cupboard will often activate the infant to crawl towards it, empty it and frequently to crawl into it.

When 10 months old, the infant begins to place objects in certain places, it may be certain toys which are placed just next to him, while others are thrown away. Or it could be the dummy, which is placed at a certain spot of the table – if the adult moves the dummy, the infant often replaces it even if it is only a few centimeters. Usually the infant places his cup very near the edge of the table. The adult often moves the cup nearer to the middle of the table, whereupon the infant moves it to the spot *he* has decided for its placement.

At 1½-2 years of age the infant begins to build primitive dens. As he is still unable to master the finer art of building he needs help. Adults usually show a lot of interest in the infant's spatial games, for example by playing hiding-games, by interacting in building dens, by staying together with the infant inside the den, by crawling in and out of it, rebuilding it, providing new materials for it and so on.

However, gradually the adult learns that the infant also wants to play on his own – that he often just needs our interest – not our interference. It seems to be the complexity in the infant's own activities which promote the understanding of spatial relations – it is not enough just to look around or to be carried from place to place.

From this survey it is obvious that very early in life the sighted infant learns about spatial relations by integrating vision to spatially related experiences and to other sense modalities. Furthermore, when experiencing spatial relations the infant includes elements of time, quantity and quality.

Thus, the understanding of spatial relations is established by the sighted infant's own activity with the entire surroundings and during the greater part of his waking hours he is quite busy including spatial relations into his scheme for further development.

The Congenitally Blind Infant.

In the uterus the congenitally blind infant has the same experiences as the sighted infant, he moves his arms and legs and has motor-tactile experience with the walls of the uterus and his own body as described in the previous paragraph.

Early motor-tactile experiences.

During the first weeks of life blind infants meet with some of the same motor-tactile experiences as the sighted infant. He accidentally touches the bedclothes, his mother, father and himself and he finds that some of the borders of his universe give away and some do not, that some of his movements result in tactile contact and some do not. He can also be found moving himself to the corner of the cot and squeezing an end of his eiderdown.

However, as vision from the very first day of life plays an essential role in early motor experiences the congenitally blind infant's experiences within this field must be quite different and considerably limited compared with that of the sighted infant (Reynell, 1978; Sonksen et al., 1984). When he waves his hand he is unable to integrate these movements with a visual impression and thereby be motivated to move his fingers even more or to play with both hands simultaneously. He is unable to learn about distances between his hands and between himself and anything else in the surroundings.

Fraiberg (1977, p. 70) states "that in the absence of vision the motor patterns for reaching and attaining an object, and for creeping and walking are impeded, and until an external stimulus provides a lure, the motor does not emerge".

Having not used his hands to the same extent as sighted infants, his hands and fingers are not motor developed enough to be used for tactile exploration and for the spatial activities of moving objects from hand to hand and turning objects around.

This means that the infant's first knowledge about structures, shapes, weight and the stability and instability of objects is so sparse or nonexistent that it is difficult for him to go further in the development of spatial relations.

In learning about spatial relations he is reduced to uniting the established tactile-motor scheme acquired in the uterus with a limit of new tactile and motor experiences and with the experiences of sounds.

Early auditory experiences.

How does the congenitally blind infant react to sounds?

The blind infant like the sighted neonate turns his head towards sound.

Fraiberg (1977) mentions that "turning towards the source of sound manifests itself in the neonate as a reflex eye movement to the stimulus of sound, a reflex which is fortified and rewarded through visual experience. I have seen this reflex-turning of the eye towards sound in a totally blind baby at two months of age and have also seen, within a few months, that the reflex had been extinguished, and the blind baby, like all other blind babies at six months, did not turn to the source of sound".

Bower (1977) studied the ability in infants to localize sounds and found that auditory stimulation just in front of the infant's middle line and therefore with the same distance from the source of sound to each ear provides the best performance.

The reason why blind infants turn their head towards sounds could, rather than being a reflex, probably be, that he is providing himself with the same distance from the sound to each of his ears. However, because he is unable to unite the experience of a sound with a visual experience, he gradually either turns his head to and fro so as to achieve alternations of the intensity of the sound, or when habituated to this experience, he may just be listening motionless to the sound. Maybe sounds become interesting only for their ability to last and to cease. Also such experiences may become habituated resulting in lack of interest in sounds, or in stereotyped listening.

To the blind infant sounds are something which can be heard, but they have no meaning which can be related to the external world. Sounds are just something which occur now and then. They do not, in the blind infant's point of view, represent an object which can be touched, pushed or grasped.

To the blind infant it is not a spatial experience to let go objects, which have been put into his hand. The very moment he lets go of the rattle, this rattle is non-existent. Although the rattle will produce a sound, when dropped, this sound is only perceived as a sudden sound unrelated to both the rattle and his empty hand. Therefore, neither the sound nor the changed tactile impression in his hand result in searching or reaching for the rattle.

Nearly, if not all the elements of spatial relations that the sighted infant experiences during the first months of life are unavailable to the blind infant, at least from the traditional care which apart from feeding, clothing, hygiene and human attachment is mainly characterized by guidance, training and games usually with the adult as the initiator.

Early experiences of small rooms.

In the perambulator the blind infant can touch the sides and experience echoes from his sucking and babbling.

While being dressed the blind infant does not experience contrasts of darkness and light. The concept of darkness does not exist without the experience of light. Because the peek-a-boo game from the sighted adult's point of view is mainly a visual game, the adult is not as inclined to play this game with the blind as with the sighted infant. Although the peek-a-boo game does not have quite the same spatial qualities for the blind as for the sighted infant, the blind infant can experience differences in temperature, intensity of sounds and the important temporal elements of "not now, but now". Consequently, without this game the blind infant receives even less input within the non-visual areas than the sighted infant. Likewise he misses the experience of pulling away pieces of clothing and the opportunity to be the initiator of the game. He also loses the chance to increase muscular strength which such games would promote.

When he is 7-8 months old, he, like all other infants, is awake for longer periods. More and more often he is placed lying on the floor. However, as he is unable to be visually inspired by his surroundings and as his muscular strength is undeveloped, he is unwilling to move himself from one place to another. However, should he accidentally push himself under some furniture, he will, like other infants, be brought "out into the open", but because of lack of sight it may be very difficult for him to repeat the action consciously. Therefore, he misses the opportunity to compare his experience of echoes in the perambulator with echoes from his activities under furniture and in cupboards.

When 12 months old he may place his dummy and later on his cup near the edge of the table. If an adult moves these objects away from the edge, he is unable to replace them.

At 1½-2 years old, he does not initiate building primitive dens. Without initiating such games adults are not inclined to help him. Therefore the blind infant misses almost all the experiences of small rooms which may have facilitated his understanding of spatial relations.

Early consequences of blindness on spatial relations.

The only real spatial knowledge the congenitally blind infant has, is that he can touch himself. When moving his arms in various directions he rarely receives any tactile response. Sometimes an object is passed in to his hand. However, because of his level of "grasp and let go" such an object is only present in his hand for a second or two which at this stage contributes very little to his understanding of spatial relations. Being unable to reach for objects and to pick up toys he does not have the opportunity to compare different objects. At the stage when he is able to grasp objects, lack of early experience of handling objects and lack of appropriate motor development affect his motivation for further exploration and experiments. He misses the experience that objects can be pushed to and fro, that some objects can be taken apart and put together. He also misses the experience of tapping objects with the other hand, towards the floor or other objects. Even when he succeeds in learning to reach for an object on the cue of sound he still has a lot of problems in understanding spatial relations. The fact that the sound from a thrown object ceases immediately makes it difficult to learn about directions and distances. Even if he wants to retrieve a thrown object to repeat an activity and tries to search for it, it is often so difficult for him to do this successfully that it is easier to give up. Too many failures may reinforce the belief that it is impossible to get hold of toys once thrown.

Under such circumstances it seems quite understandable that some blind infants are inclined to turn most of their activities towards their own body, become all too passive or develop some sort of stereotyped or autistic-like behaviour (Burlingham, 1972; Jan et al., 1983; Warren 1984).

This survey shows that the blind infant very soon after birth misses important elements for the understanding of spatial relations. The lack of vision causes delayed motor development which decreases the utilization of the intact sense modalities. The oppor-

tunity to integrate experiences of time, quantity and quality to spatial relations is severely diminished compared with that of the sighted infant.

Experience of Permanence and Concept of Object in Sighted and Blind Infants

The Sighted Infant.

1.1.5 According to Piaget (1954) permanence and concept of objects are structured gradually. During the first 4 months of life the infant recognizes what he sees but this had no permanence or spatial organization. By turning his eyes towards an emerging sound he sees the sound-based object or individual. Gradually he learns about the relationship between certain sounds and certain visual pictures. Such visual-auditory experiences contribute to the infant's experience of the solidity of the external world but not as yet to knowledge about permanence or proper concept of objects.

At about 4 months old he begins to coordinate vision with grasping. But at this stage of development the grasped object does not reflect permanency. As soon as the object is out of sight, it no longer exists (Bower, 1977). Between four and eight months of age he begins to move the grasped object to his mouth and to the other hand. By looking at these acitivities and by looking at moving objects and individuals in his surroundings the beginning of differentation between an object and his own reaction to that object is established. He obtains the basis for future displacement of objects. However, he does not as yet perform systematic search for absent objects.

Between eight and twelve months of age the infant begins to look for objects in which he is especially interested. However, he gives up if the object can not be directly perceived.

Between twelve and eighteen months of age the infant becomes able to imagine that an object still exists even if it has been covered. By crawling and walking he is able to move towards objects and individuals in his surroundings, but until the age of about sixteen months he will only look for invisible objects or individuals at the position where he last saw them. By moving around he learns that objects can be found at many different places and that objects can be found also at positions where he has not seen them before.

In this way the sighted infant obtains the idea of object permanence so that at about the age of eighteen months he has an image of absent objets and their displacement.

While learning about object permanence the sighted infant also learns about object concept. By looking at an object and by comparing the views of different objects he learns about shapes, colours and the structure of surfaces. Holding each end of an object he can see that it is one object. He also learns that an object whose form can be changed by handling is still the same object. By seeing a fragment of an object he can imagine the view of the whole object. By moving towards a seen object and by looking from one object to another and also from comparing the view of an object with the view of his entire environment he learns about distances and directions. His ability to see enables him to obtain a great deal of information about a present object in only a few seconds.

The Congenitally Blind Infant.

According to Piaget's definition of "object permanence" a child knows that an object exists if she or he searches for it when it is hidden (1954).

But what is a hidden object for a congenitally blind infant or child?

Lack of sight means that the congenitally blind infant has to rely on the remaining sense modalities to learn about the existence of the external world and to understand the permanence of objects. However, as outlined in chapter 1.1.4 the blind infant's experiences with objects are very limited. Because of poor motor development and ignorance about relationships between sounds and objects he has extreme difficulty in understanding the permanence of objects. Fraiberg (1977) states that "in the first stage of building the object concept the blind infant must trace the object's displacements by means of perceptual cues that are highly inadequate substitutes for vision. Audition, for example, can substitute in tracking only certain classes of objects – those that have sound-making properties. Tactile experience cannot tell the infant where he has lost contact with it. The blind infant then, has a fragmentary and discontinuous experience with objects during the period of tracking and probably can evolve a concept of the independence of objects from his own perceptions only after his own

locomotion provides him with spatial references and repetitive experiences with object finding".

However, a blind infant cannot be expected to search for objects as long as he is ignorant about the fact that the world is full of objects. Learning about displacement of objects is for the blind infant based only on his own activities such as moving objects from hand to hand, letting go objects in different directions and searching his nearest surroundings. When the mother leaves her congenitally blind infant he does not perceive her as being in another place. The idea of "another place" does not exist until the congenitally blind infant has begun to perform tactile search of his nearest surroundings.

Fraiberg (1977) also suggests that "it is undoubtedly the human object that provides maximum experience for the blind infant's building of an object concept." Nevertheless, even in cases where the blind infant receives a lot of human contact including stimulation with toys, he has enormous difficulty in learning about permanence sufficiently enough to enable him to search for objects.

Tobin (1980) mentioned that like Fraiberg he had noticed that there is not much evidence of active searching in blind infants. He reported on a boy who at the age of 14 months played with a balloon and displayed great pleasure at the noise it made when he rubbed his hands on it, but did nothing when it floated away from him. Similarly at 19 months, he showed no response when his four years old brother turned off the tape-recorder he had been listening to. Tobin believed that it was premature to declare that this indicated a delay in attaining awareness of the permanence and independent existence of external objects. He suggested that the absence of search procedures could be attributable to inadequate feedback about success or failure of preliminary movements, and such movements may therefore have been extinguished.

To this suggestion I put the following question:

How can the environment around the congenitally blind infant be organized during the first months of life to encourage him to perform the preliminary movements through which he can get feedback about success and failure in connection with objects and spatial relations?

Maybe the 19 months old boy had achieved some knowledge about object concept but no knowledge about the permanence of objects.

However, where learning about object concept is concerned, the congenitally blind infant also has difficulties. As long as he is unable to move an object to his mouth or to the other hand the tactile experiences he can gain from having an object passed in to his hand are very few. Without performing tactile search with his hand or mouth he can only feel that part of the object which is in his hand. While just holding each end of an object he does not know that the object in fact is one object. If he is given one object in his left hand and another object in his right hand he does not know whether they are attached to each other or are separate objects. When his motor development enables him to turn an object around he is unwilling to do so as long as he does not know that such behaviour can provide him with a new sound, or a new tactile experience. The object in question must also have such properties if he is to be motivated for searching procedures. At the stage when he is motivated and able to perform searching procedures he must use several seconds or even minutes to learn about the entire quality of an object: its shape, its size, its stability and also its tactile, auditory, olfactory and taste qualities. He must also be able to remember all the different perceptions obtained and the relation between them, if he is to achieve an image of a connected whole. Depending on the size and the amount of details of an object he has to rescan it several times. However, even if he uses all his energy and all his remaining sense modalities, the concept and image of objects he achieves can never be compared with those of the sighted individual.

Experiences of Causality in Sighted and Blind Infants

The Sighted Infant.

1.1.6

By repeating the same activity several times and by playing sequence-games the sighted infant learns about the connections between his own actions and the affect on himself and on the world around him, including other individuals, events and objects. Visually he is able to control the causes of happenings of both his own activities and others. From day to day he uses the achieved and still increasing scheme of knowledge about time, quality, quantity and spatial relations in learning more and more about causality.

The increasing knowledge about causality enables him to transfer an ability gained from one acitivity to be used in another activity and gradually he achieves the ability of imagination. This enables him to recall other individuals and different objects and events. Likewise, it enables him to remember events, individuals and objects and to remember what these can be used for. By experimenting with both events and objects he learns what is possible and what is impossible and during infancy all this happens mostly from his own concrete experiences.

Knowledge about causality enables him to imagine that an object exists even if it has been hidden and later on to remember where he has placed an object even if he has done so some time ago.

All this will after some years of practicing provide him with the ability of more abstract operations in his thinking as well as in his actions.

The Congenitally Blind Infant.

The congenitally blind infant also repeats certain activities several times, but the amount of varied experiences about connections between his own activities and the effect on himself and the outside world are very few compared with that of the sighted infant. Often traditional care and traditional surroundings do not provide enough opportunity for performing sequence-games and to control the causes of happenings. The lack of knowledge about causality effects his ability to display interest in his surroundings. He becomes delayed in performing those exploring activities, which during infancy would have facilitated his ability to transfer gained ability from one acitivity to another and to recall, imagine and remember events.

The Blind Infant and the Reality of the World

1.1.7 This survey of factors affecting the understanding of the reality of the world shows that knowledge about spatial relations and of quantity seem to be most crucial for the blind infant to achieve. Piaget (1954) mentions the necessity of equilibrium of the levels of understanding time, quantity, quality and spatial relations. Without such an equilibrium the blind infant seems to have problems in developing understanding of the reality of the world.

It may probably be that those blind infants who succeed in achieving a relatively proper equilibrium of understanding the aspects of time, quantity, quality and spatial relations are those who later on catch up with their sighted peers.

It might also be hypothesized that those blind infants who are unsuccessful in achieving a current equilibrium in learning about the four aspects are those who become so delayed that they become autistic or appear to be mentally retarded.

The ability to develop understanding of spatial relations early enough in life to avoid an unbalanced understanding of the reality of the world, may depend on the environment around the congenitally blind infant.

Delayed Development: Influence on Care

1.1.8

What are the reactions of the parents and other caregivers while observing delayed development in the blind infant?

The blind infant who is mostly occupied in touching his own body does not seem to alarm parents and other caregivers. This behaviour is so similar to the behaviour of sighted infants that the adults only later discover that the blind infant is not doing anything else.

If the blind infant begins to display stereotyped behaviour the parents may be anxious that the child is suffering from diseases or impairments other than blindness. The parents' ability to stimulate their blind infant must be affected by the anxiety and bewilderment they experience if the infant starts to develop stereotyped behaviour.

If the blind infant is observed to be very passive, he is either thought to be tired, or the adults try to stimulate the blind infant by shaking rattles, repeatedly putting the same or a few different objects into his hand or by making other efforts to please him. The result can be that the mother or caregiver tries to please the infant nearly all the time without allowing him much opportunity to be active on his own. This means that the infant is being held whenever he is awake. From this he may conclude that that is how his position must be when awake. There is a risk that an unnatural symbiosis between the mother and the infant is built up, instead of the infant becoming more and more independent on his mother. Furthermore, the spatial relations the blind infant is able to

achieve by being held most of the time is very poor. Of course interaction is necessary, but only when both infant and adult are contributors to the interaction. Interaction which is characterized mostly by active contribution from the adult with the infant as the recipient is inappropriate for the infant's social and emotional development. It is also inappropriate for motivating the infant to be active on his own within his environment. Lack of real interaction during infancy may affect the ability to achieve independence.

However, traditional environments and traditional care seem to be insufficient in providing the blind infant with the appropriate opportunity to achieve early knowledge about the reality of the world.

Would some other less traditional type of environment and care during infancy be more suitable in the unusual situation of being congenitally blind?

Early Studies

1.2 Numerous studies have been performed to illuminate the problems many blind children have with spatial relations. In most of them the blind subjects have been more than 5 years old; few studies have dealt with blind children between the ages of 2 and 5 years. In the conclusions of several studies about spatial problems in congenitally blind children the authors suggest that the reasons for these problems are probably due to very early deprivation of spatial experience (Drever, 1955; Elonen & Zwarensteyn, 1964; Freedman, 1968; Jones, 1975; Leonard & Newman, 1967; Stephens & Grube, 1982; Warren & Kocon, 1974; Warren, 1984). Studies on congenitally blind infants are rare and only a few of them have dealt with spatial relations (Adelson & Fraiberg, 1974; Bower, 1977; Fraiberg, 1977; Gerhardt, 1982; Wills, 1970).

The Fraiberg research was carried out from 1963 to 1973. Compared with other studies of blind infants it is extensive, as 10 congenitally blind infants were followed in a longitudinal study which included a guidance program designed to facilitate development in blind infants. At the start of the study the infants were 1 to 11 months old (1 to 8 months with correction for prematurity in 3 cases). In Fraiberg's description of the infants before the intervention program started, she pointed out that, "the hands of the infants did not reach out to attain objects or to get information

about them. Most strikingly, the hands had remained in a kind of morbid alliance with the mouth. They could bring objects to the mouth to be sucked. But, when the hands were not serving the mouth in some way, they were typically held at shoulder height with stereotyped unutile movements of the fingers".

The result of that part of the Fraiberg study, which was directed towards spatial relations, showed that it was not possible to get blind infants to reach for objects on the cue of sound until the age of about 10 months (1977, p. 166) and that blindness is associated with a marked delay in the achievement of mobility skills as long as the infant has not begun to move towards a sound (1977, p. 207 and p. 278). The infants in the study began to crawl very soon after learning to reach for objects on the cue of sound and the mean age for walking alone, was 19.25 months.

During the intervention program Fraiberg and her coworkers played games to promote midline organization of the hands; the mothers were encouraged to place the infant's hand on the bottle; dangling toys which would give the infant both tactile and auditory experience when touched, were placed over the infant in the midline. Patty cake games were played with the infants, and sounds were made with bells and other objects just in front of them. For infants who could sit without support a table with a tray top providing a 100° arc for exploration and mapping was used. The tray itself had a rail which defined its boundaries, and it was furnished at any one time with two or three toys of tactile and tactile-auditory interest. The tray top became "the place" where exciting objects could be found.

Fraiberg paid attention to the fact that the ten infants probably achieved the ability to reach for objects on the cue of sound earlier in life than they would have done without the interventions during the study. She suggested that congenitally blind infants should receive a lot of attention from parents and other caregivers, who should employ strategies to bring about midline organization of the hands, and to establish an environment which would provide the infant with maximal engagement and experience with both people and objects. Fraiberg also suggested placing the infant in a playpen, allowing the infant to search for objects within a larger frame of space.

Fraiberg (1977) stated that "if a blind baby has not demonstrated 'reach on sound' all efforts to entice him to creep with a dis-

tant voice or sound will fail" and "many parents and educators may attempt to 'teach' a blind baby to creep by putting him through the exercise of creeping, manipulating his legs and arms. It is a method doomed to failure and typically results in a resistant and outraged baby who flips over on his back and has a monumental tantrum".

Wills (1970) described her work with 9 blind children and her observations from their years of infancy. Unfortunately it was not mentioned how many of them were congenitally blind. During her work with the infants she tried to get them to reach for objects on the cue of sound. She did not describe how this was done but she mentioned that these blind infants could not reach for an object on the cue of sound until the ages of 12 to 18 months, and that this happened at about the time when the infants began to crawl or walk. Moving about "seemed to speed up their understanding that sounds had a source and could be located". Wills therefore underlined the importance of the infants being able to move themselves nearer to, or further from the source of sound, either by crawling or walking.

Warburg (1982) investigated 300 severely visually impaired, mentally retarded children and found that lack of gross motor skills has an extreme impact on the childs development. "Altogether, children unable to walk were rated as profoundly mentally retarded... If the children do not move or grasp it is very difficult to know how much they understand and this will often be interpreted to mean that they understand very little. There is an obvious need for more refined methods of rating the development in these children".

Personal Experience

1.3 During the past decade I have used the Fraiberg approach for intervention with the help of parents of congenitally blind infants and other caregivers. The results were reasonably satisfying, the infants seemed to be less passive than experienced earlier, and they began to walk independently before the age of 2 years.

However, in some cases it was difficult to encourage the blind infants to perform midline activities of the hands. When the hands of the infant were placed on the feeding bottle, they nearly always returned immediately to the position beside the ears. If the infant

never moved his hands spontaneously he would not touch the dangling toys hanging over him. In the patty cake games these infants were not really participating, the action continued to be totally performed by the adult guiding the hands. Despite all efforts some of the infants continued to put one of their hands into their mouth, but when given a toy they did not bring this to their mouth. Some blind infants held their hands at shoulder height all the time and some of them did not even make the finger movements mentioned by Fraiberg. Some began to perform the hand-mouth acitivity in a stereotyped way, and as time went on it became more and more difficult to motivate these infants to be active with anything at all. Despite proper caretaking together with interventions like those suggested by Fraiberg, and despite apparently normal potential for development, some congenitally blind infants had great difficulty acquiring skills which would enable them to reach for objects on the cue of sound or to perform other activities which could promote their awareness of spatial relations.

Many parents and other caregivers have trained blind infants to crawl and walk in order to help them to move towards objects, and to find their way in the external world. Some blind children apparently benefitted from this, but since other approaches were used as well, it cannot be said for certain that the mobility-training was specifically important. Furthermore, it is my experience that among those blind infants who actually learnt to walk from the mobility-training, some did not use this ability independently and it did not contribute to their understanding that sound has a source and they were often unable to grasp for objects. So it became necessary to try and find other solutions. However, because of the few studies carried out on congenitally blind infants, everyone working with them had to make their own trials, and learn from discussions and papers dealing with considerations and suggestions on how to help blind infants, but without any research-based evidence.

One of the trials was the Guidance-approach (Cratty, 1971; Sonksen, 1979; Holt, 1979). Instead of replacing a toy in the hands of the blind infant when he had let it go, his hand was guided to the toy and "out there" it was replaced in his hand. The guidance-approach also involved guiding the infant's hand to touch surfaces of different textures, as well as the shape of

different toys and objects. However, this approach seemed to give a rather limited improvement. In fact, I found that some of the infants who most obviously needed intervention seemed to react negatively to the guidance; they began to withdraw their hand whenever anyone began to guide it, and this behaviour became so extreme in some cases, that they also began to withdraw their hand whenever they accidentally had tactile contact with objects. Some infants reacted differently. From interactions based on guidance and human attachment the adults succeeded in getting the infant to do something with the toys, but as soon as the adult left the infant on his own together with the toys he did nothing at all. If the adult played a passive role, the infant became passive too.

Personal Observations

1.4 Personal observations of the passivity of some congenitally blind infants and their apparently little interest in the toys offered them, made me wonder if perhaps they were interested, but that it was too difficult for them to get hold of the toys. Blind infants do not often come into tactile contact with objects when they move their arms and feet. So in 1969, I began to place blind infants and preschool children who were unable to pick up toys, among 20 to 30 objects and toys. The philosophy was that such an environment would provide the blind infant with contact whenever he moved, and hopefully this would give him a starting point in search for toys. Sometimes I was told that all the objects might confuse the infant and make him overstimulated.

However, it occured to me that blindness meant that the congenitally blind infant was unable to know how many items there were around him; every single object only existed for him the moment when he touched it, and for as long as he was in contact with it. It also meant that while he was touching, pushing, grasping or doing whatever with one of the toys, the rest of them did not exist until the day when he had attained at least a pre-understanding of object permanence. Therefore, in my opinion, the blind infant could not be overstimulated by something he was not aware of. On the contrary, the blind infant could presumably be considered as understimulated in an environment containing only two or three objects; in fact he would be very lucky if he happened to

touch one of these objects when he did not know where they were placed or whether they were there at all.

The result of giving the blind infant a lot of toys, was that some of them not yet able to sit without support and therefore lying supine or prone began to push the toys either with their arms or with their legs, and later on they began to grasp and let go of some of the objects. They also began to bring objects to their mouth to suck them.

Some of those blind infants and preschool children, who could sit alone, but were unable to reach for objects on the cue of sound, and who were also unable to pick up toys by themselves, began to do so when offered a lot of objects placed around them or in a box. In the beginning they just picked up and immediately dropped every single toy they came in contact with; later on they would shake the toy, and little by little they began to explore it by touch. The next step seemed to be that an object which was apparently particularly enjoyable, was not thrown away but placed just beside the thigh of the infant or child. This behaviour I interpreted as pre-understanding of object permanence (see chapter 1.1.5), at least in connection with that particular object. This interpretation was supported by the fact that very soon after this they would begin to search for objects and to choose an apparently preferred one amongst several objects. Then they began to move themselves from the spot where they had been placed.

However, even though some of the blind infants who could not sit alone actually began to touch and push the toys, they would not begin to grasp. Touching and pushing seemed to be unconnected with grasping, or rather, an object which could be pushed was different from one which could be grasped. Instead they returned to passivity or automatism, as for example sucking their hand, hitting themselves or eye-pressing.

Some of the blind infants and preschool children who could sit, were surrounded by many objects, but they did not go through the expected developmental steps that would lead to walking. They started by touching and grasping the objects, but they continued letting the object go after holding it for one or two seconds. Instead of exploring the toy by rattling or touching, some of them began to throw the toy and became in some way arrested in this behaviour, they did not try to get hold of specific objects. Even if they were helped to get the same object once more, they only

seemed to be interested in it for the purpose of throwing it continuing such behaviour for months or even for years.

Not all the infants began to throw objects, some of them stopped picking up toys and instead turned their activity to stereotyped behaviour with their own body. Thus, the environment with a lot of objects seemed to establish reasonable improvement in some blind infants but definitely not in all of them. The question was, what else could be done?

Warren et al (1973) made a review of studies dealing with spatial behaviour in blind children and concluded that "if vision provides an organizational function for the sighted child, and if early vision provides a residual organizational framework for the child blinded after two or three years of age, what is the most effective remedial program that can be instituted for the child blind from birth? ... it seems likely that the early years, perhaps up to five, provide the most fertile ground for establishing in the congenitally blind an auditory-proprioceptive organization that is maximally useful in structuring spatial relations".

This made me consider whether the environment could possibly be changed in some way to provide an auditory-proprioceptive organization for the congenitally blind infant, or the blind child who still functioned at the level of infancy. Congenitally blind infants seem to be unaware of the sound they produce when letting go objects, they seem to be unable to connect the sound from a toy just dropped with their own activity. They were reacting to sounds, but they did not seem to know that they themselves were sometimes the producer of a sound. Blind children who still functioned at the level of infancy displayed the same picture.

The Resonance-platform

1.5 Blind infants and children who still functioned at the level of infancy were normally placed on mattresses, blankets or carpets. I formed the idea that some other type of support might be more effective.

In 1976 I constructed the resonance-platform (Nielsen, 1979, 1983) and began to place blind, mentally retarded infants and children lying down or sitting on top of it (Photo 1).

The resonance-platform reinforces every sound the infant or child makes with every movement of his body, by pushing or any

Photo 1

other activity with the toys around him. The aim of the resonance-platform was to give blind infants and children auditory feedback of their activities.

During 1976-1978 the resonance-platform was used mostly for blind, profoundly or seriously mentally retarded children. The result was that many of these children who had been nearly totally passive became remarkably active; they began to scratch with their nails and later on to kick the surface of the resonance-platform, clearly enjoying their activities. They began to push the toys placed around them and they began to move themselves in some way or another. Little by little they became aware of the sounds they produced by pushing, grasping and letting go of the toys.

Windahl (1979) compared the motor activities of a blind, severely mentally retarded boy placed respectively on a mattress and a resonance-platform, and found that the use of soft foundations in future treament of severely multiple handicapped children should be absolutely minimal.

Since 1979 the resonance-platform has been used not only for blind mentally retarded, but also for blind infants and children, who were thought to have normal potential for development.

Voluntary Movements

In a discussion about the spatial perception of the blind, Jones (1975) advanced the hypothesis that all spatial distinctions are founded upon voluntary movements. Jones did not define the

1.6

word "voluntary" but he stated that if the range of spatial distinctions which the child can make depends upon voluntary action, then lack of adequate experience of voluntary movements would have perceptual effects. Furthermore Jones speculated that particular movements may be involved in particular spatial judgements. "Since vision clearly does provide a rich source of information about things and events at a distance from the child's own body, the blind baby will have that much less reason to explore his environment and specifically, because the baby cannot reach for objects unless he knows they are near him, the blind may lack experience compared to the sighted of the particular patterns of movement necessary for tactual exploration".

In my opinion voluntary movements refer to all unrestricted movements performed by the infant ranging from undirected and spontaneous to more consciously directed movements, while movements performed by interference by another person such as guiding the infant's hand to objects, or guiding the hand to search structures of surfaces, are not considered as voluntary movements.

Macmurray (1968) stated that the very first experience with another thing, another organism or another person is a tactual perception and that tactual perception is necessarily perception in action. He also stated that the capacity to act is represented by the capacity to move.

However, blind infants are often observed as performing fewer movements than sighted infants (Fraiberg 1977). When spatial experience and spatial distinctions are founded on movement it is therefore important to discover how congenitally blind infants can be persuaded to move. Blind infants unresponsive to previous intervention are particularly in need of a new approach.

During the past decade much energy and imagination has been used to provide the blind infant and child with toys and other objects, which would bring about an increase in exploration, examination and searching, thereby improving their interest in the external world (Barry, 1973; Barton et al., 1980; Burlingham, 1968; Hewson et al., 1980; Nielsen, 1979, 1983; Newson & Newson, 1979; Thomas et al., 1981). Also many unpublished papers with valuable suggestions about toys and games for blind children began to circulate among parents and teachers.

The result has been that some blind infants seem to be playing much more than was observed some years ago. Even if the infants often play with a single toy only for a short time, so that new toys have to be provided repeatedly, the infants have achieved more awareness of spatial relations than formerly.

However, providing blind infants with objects with many different surfaces, forms and auditory properties failed to promote improvement in all of them. Some of them seemed to be unable to relate their handling of these objects to the external world. Even though an activity with a certain object was clearly enjoyable they still made no attempt to find the object when they lost it. It was as if they considered an object as existing only as long as they were doing something with it.

Even if some blind infants and children during the past one or two decades have shown better awareness of spatial relations, there are still those who lack perception of spatial relations, so that they are unable to cope with the external world through their own activities.

Warren (1984, p. 25) stated that "the question of how to provide *effectively* coordinated tactual and auditory experience [in blind infants] has received relatively little attention. Spatial relations include concepts of relationships among objects in external space. Spatial abilities will be more adequate in individuals who have an adequate concept of the existence of space independent of their own bodies .... It seems likely that any experience designed to produce external spatial relations concepts will automatically produce observer-based spatial concepts, as long as the experience involves active participation by the child".

The idea of establishing a specific environment to provide further opportunities for congenitally blind infants to achieve the first spatial relations arose from my experience with a boy called Tim and from the considerations which came from these experiences.

Interactions with Tim

Tim was 20 months old. He was sitting on the floor, ceaselessly tapping his chin with his right hand. I knew that he had had a normal hearing test, but I also wanted to know how he reacted to sounds. At a distance of 30-40 centimeters from his head, I shook

1.7

a rattle. He reacted with a listening posture, but continued to tap himself. He did not try to grasp the rattle or make any other sign which could be interpreted as, "the object which makes a noise – I want that". At the same time, his facial expression very clearly said, that he was listening and that he enjoyed the sound.

My interpretation of the sitation was that although this boy is 20 months old, he has not succeeded in comprehending that sounds can represent objects, which can be reached out for.

The parents told me later that Tim had begun the described tapping-behaviour when he was about 6 months old, and was now performing it during all his waking hours.

When I had observed that the reaching-reaction was missing, I took a plate and held it in front of Tim so that he would also tap the plate when he tapped himself. After getting this new effect a couple of times, he stopped tapping himself for a few seconds with a very surprised expression on his face. I moved the plate away. When he tapped himself again I held the plate in front of him, so that once more he got the new effect from his tapping. This time he reacted by tapping the plate several times without simultaneously tapping his chin.

A few minutes later I placed him sitting in a corner of my "treasure chest" with a lot of objects surrounding him. He was tapping himself on the chin while I began to play several games without telling him anything about what he was supposed to do. I said nothing at all. When I began to play "grasp and let go" with different objects, Tim moved his right hand towards the objects around him, grasped an object and let it go. In the following hour he alternated between tapping his chin and grasping the objects.

The parents were advised to occasionally sit Tim on a resonance-platform (description chapter 2.3) with a lot of objects around him. In this way he began to vary the activity of grasping and letting go by directing most of the objects over his shoulder before letting them go.

My second interaction with Tim took place two weeks later. During the first 30 minutes he was grasping and letting go, and only tapped himself a very few times. Then I took a balloon, put 2 beans into it and blew it half full of air, tied it and gave it to Tim.

A balloon which is only half full of air has a good handle and just a small movement results in a special enjoyable sound from the beans.

Tim began to make shaking movements with the balloon, and he also began to experiment with where in relation to his own body he could produce the sound. He alternated with moving his hand with the balloon straight to the right, obliquely forwards and backwards, and also up and down. A little later he moved the balloon to his left hand (it was the first time of his life he had ever moved anything from one hand to the other) and made the same experiments about where in relation to the left of his body he could produce the sound. Now and then during the next hour of experiments with the balloon, he placed it beside him and took some of the other objects around him and let them go to the right or to the left or over his shoulder.

At the end of the hour of experiments with the balloon he again placed the balloon beside himself. While playning "grasp and let go" with the other objects he now and then touched the balloon for a second. This I interpreted as a sign that Tim had now achieved understanding of object concept, at least in connection with the balloon.

When Tim was 10-12 months old his parents had begun to train him to walk. The result was that when he was 20 months old he was able to walk while somebody was holding his hand and if asked he would take a few steps without holding anybody's hand. However, by closer observation it appeared that Tim enjoyed walking but was afraid to do it by himself.

I suggested that it would be better not to encourage him to walk independently. With such a poor relationship to the outside world as he apparently had, he was not yet motivated to move himself from one place to another. Selma Fraiberg (1977) has strongly warned against using traditional training methods to teach blind children to walk when they cannot reach for objects on the cue of sound.

From the age of 20 months to the age of 36 months Tim went through all the phases that non-handicapped children go through when learning to walk alone. He started by sitting on his bottom and moving himself a few centimeters in order to reach an object

that he had thrown away, but wanted once more. Later on he used a sort of creeping to move himself from the sitting room to the kitchen. Still later, he began to pull himself to a standing position with the help of the furniture, and as soon as he had achieved this position, he sat down and immediately tried to pull himself back up. A few days later he let go of the furniture but grasped it again after a second or two. A week later he went one step backwards from the furniture and then one step forward towards it. In that way Tim learnt to walk independently. It is the same procedure that all non-handicapped children use.

These events also mean that Tim, who had been trained in walking with reasonably good results, had to learn to walk independently as well – and that is thought-provoking.

Implications from the Interactions with Tim

1.8 The observation of Tim's behaviour lead to speculations about what could have been done during his very early life to give him a better chance of learning to reach for objects. I thought that had he had more experience with objects from the outside world, he probably would not have started his stereotyped behaviour. My considerations also involved his suprise when he tapped the plate for the first time. I chose the plate because I thought the sound would be familiar to him, but when I considered the situation I realized that in holding the plate in front of him, I had also given him a touchable boundary for his activity.

Eventually, I came to the conclusion that the problem had something to do with understanding spatial relations as defined in chapter 1. Tim was an infant without motor handicaps. Because of blindness he had not begun to reach for objects by the age of 4-5 months and he had not developed awareness of space. He could not talk, he was not even vocalising although he was a normal hearing child.

Due to the lack of understanding of spatial relations he had also not started to reach for objects by the age of 10 months, unlike other congenitally blind infants. Previous studies (Adelson & Fraiberg, 1974; Freedman, 1971; Wills, 1970) have shown that 10 months is the age at which a blind infant can reach on the cue of sound.

At the age of 20 months Tim was deprived of activities which would encourage curiosity and he was deprived of situations with appropriate problems, which would challenge him to explore the world around him. He had turned all his activity towards his own body.

Despite the best possible care from both parents and despite the fact that a lot of different toys had been placed into his hands daily, and efforts had been made to teach him to reach for objects at the cue of sound, this boy had no knowledge about spatial relations.

From this it seemed that it was not enough for a congenitally blind infant to be given objects – it was not enough to shake rattles or anything else to persuade the blind infant to reach for objects. The fact that Tim had to learn to walk independently even if he was very good at walking when held by the hand, could possibly indicate that a blind infant has to learn to reach for objects both by his own activities and through interaction with other people.

This experience with Tim made me wonder if it would be possible to give blind infants a specific environment which could serve as a source of inspiration for exploration of the surrounding world?

The aim of the present empirical study is to observe whether a specially designed experimental environment would facilitate the development of early spatial relations and to observe which properties of this environment would improve the development of spatial relations very early in life of the congenitally blind infant.

The problems of development of awareness of space in congenitally blind infants and children are so extensive that it is not considered possible within the framework of the present study to provide more than a starting point for further studies.

The Effect of "The little Room"

The idea of preparing the material called "The little Room" arose from my experiences with Tim. The material was prepared so that it might help blind children to achieve a frame of reference for understanding space.

Pilot Study

2.1

During 1984, in connection with preparation of a prototype for the production of "The little Room", 40 blind, profoundly mentally retarded children aged 8-18 years were offered the material. In a questionaire the teachers described the observed acitivities of the children. The result was that 39 of them became more active than they had been before. This led me to wonder if "The little Room" would be of help to congenitally blind infants in their development of reaching and in their awareness of the surrounding world?

Subjects of Present Study

2.2

For this investigation the subjects were 20 congenitally blind infants aged 5-19 months.

None of the subjects had taken part in other investigations before or during the week that they participated in this study.

The infants represent 20 of the total population of 23 congenitally blind aged 5-19 months in Denmark in 1985. Two parents refused to have their child participating and one blind infant was excluded because of deafness.

Even though the sample was nearly the whole population of congenitally blind infants in 1985 it cannot be stated that their behaviour or the development which might occur from their participation in the study is general for all blind 5-19 months old infants.

All infants were blind from birth and unable to reach for an object on the cue of sound and move alone from where he was placed. Only infants with the additional impairment of deafness were excluded.

The reason why blind infants who suffered from other additional impairments than deafness were included in the study, was partly that it was impossible to be quite sure whether an infant really suffered from, for example, mental retardation or not, and partly because observation of blind mentally retarded infants might show whether the second impairment was the reason for their developmental delay or not. About 80-85% of the mentally retarded blind infants and children are severely or profoundly retarded (Warburg et al., 1979).

The reason for excluding the deaf-blind was that the experimental procedure of "The little Room" was to a high degree based on sounds.

The subjects for the study were found from the National Register of Blind Persons. The parents of the infants were informed by letter about the study and asked permission to let their infant participate. The request was met with much interest.

The sample consisted of 7 female and 13 male infants. The youngest was 5 months 14 days old and the oldest was 19 months 15 days old (Table 1). Nine infant were premature (Table 2). Eleven infants had no second impairments.

Of the 9 infants with second impairment 5 were diagnosed as mentally retarded and 4 had diagnoses which normally are associated with mental retardation; furthermore, compared to their ages, they were very developmentally delayed.

Survey of the Material Table 1

Case no.	*Sex*	*Age in months*	*days**	*Diagnoses*	*Comments***
1	M	11	25	Epilepsy, mental retardation, hypoplasia of the optic nerves, congenital malformation of the brain (Dandy Walker)	
2	F	12	23	Optic atrophy	No additional impairments
3	M	14	8	Hydrocephalus	Mental retardation
4	M	7	29	Hydrocephalus, congenital amaurosis	Mental retardation
5	F	11	4	Leber's congenital amaurosis	No additional impairments
6	M	12	22	Cerebral palsy, epilepsy, cortical amaurosis	Mental retardation
7	M	13	3	Congenital amaurosis	14 weeks premature
8	M	9	0	Retinopathy of prematurity	10 weeks premature
9	M	6	3	Retinopathy of prematurity	12 weeks premature
10	M	14	20	Cortical amaurosis, epilepsy, mental retardation, cerebral palsy	
11	F	11	7	Retinopathy of prematurity	11 weeks premature
12	F	5	14	Porencephaly, bilateral anophthalmos	No additional impairments
13	M	9	3	Retinopathy of prematurity	14 weeks premature
14	F	8	20	Cortical amaurosis	No additional impairments
15	M	12	24	Optic atrophy, neonatal asphyxia, mental retardation	
16	M	8	10	Retinopathy of prematurity	12 weeks premature
17	M	16	23	Retinopathy of prematurity, mental retardation	8 weeks premature
18	F	15	11	Retinopathy of prematurity, cerebral palsy, hydrocephalus	12 weeks premature, mental retardation
19	F	19	15	Optic atrophy, microcephalus, mental retardation, epilepsy, cerebral palsy	
20	M	8	1	Retinopathy of prematurity, hydrocephalus	14 weeks premature

* At the first day of experiment.
** Mental retardation indicates that the infant had not been psychologically assessed, but appeared mentally retarded.

Table 2

Survey of Age. Prematurity and Birthweight

Case no.	*Age in months*	*days**	*Prematurity in weeks*	*Birthweight*
1	11	25	0	3700
2	12	23	0	3400
3	14	8	0	3600
4	7	29	0	2800
5	11	4	0	3350
6	12	22	0	3650
7	13	3	14	850
8	9	0	10	1520
9	6	3	12	980
10	14	20	0	4400
11	11	7	11	1355
12	5	14	4	2720
13	9	3	14	840
14	8	20	0	3720
15	12	24	0	3700
16	8	10	12	1250
17	16	23	8	1420
18	15	11	12	1100
19	19	15	0	3710
20	8	1	14	1000

* At the first day of experiment

Table 3

Survey of Systemic and Ocular Disorders

1. General impairments:	
Neonatal asphyxia	1
Congenital malformation of the brain (Dandy Walker)	1
Hydrocephalus	4
Microcephalus	1
Cerebral palsy	4
Porencephaly	1
Mental retardation	5
Epilepsy	4
2. Ocular impairments:	
Hypoplasia of the optic nerves	1
Congenital amaurosis	2
Cortical amaurosis	3
Retinopathy of prematurity	8
Optic atrophy	3
Leber's congenital amaurosis	1
Bilateral anophthalmos	1

The diagnoses were ascertained from the medical reports in the Register on blind children, National Eye Clinic for Visually Impaired. The number of diagnoses is larger than the number of infants because several infants had multiple impairments as shown in Table 1.

All infants but one were looked after at home. 10 of the infants were cared for by the mother alone, 2 were looked after in their own home, but for 4-6 hours a day a nurse was in attendance. One of the infants was cared for in another home for 6-8 hours of the day by a woman who also looked after sighted infants, 3 were cared for in the home of a woman who was not caring for other infants. 3 attended a daycentre. The 20th infant was placed in an institution for profoundly mentally retarded children.

Apparatus and Stimuli

"The little Room" (Photo 2) was placed on top of a resonance-platform. For the best resonance effect the platform should be made of plywood, and raised off the ground by a 2 cm × 2 cm rim of wood attached to the underside perimeter of the plywood. It normally measures 120 cm × 120 cm, or for a larger child 150 cm × 150 cm.

2.3

The resonance-platform used for this study was made in the same way but for practical reasons it only measured 65 cm × 90 cm.

To provide a varied textured surface two pieces of Braille-plastic with reliefs, one with ridges the other with nodules were fastened to the resonance-platform so that the infant could touch them at each side of his body.

"The little Room" is composed of metal pipes 1½ cm in diameter, which can be put together to form the frame of a little room. Several plywood panels can be placed on the pipes serving as walls and ceiling. Each panel measures 30 cm × 60 cm. The surfaces of the wall panels are each covered with a different material.

On the surface of the wall to the right of the infant (when lying on his back) string was arranged in a squared pattern. The string is tied so that there is 1 cm between the string and the plywood wall. To the left of the infant the plywood was covered with artificial grass.

The wall behind the infant was made of plywood with round bars placed vertically at intervals of 4 cm and with 1 cm between the bars and the plywood.

The two panels used for the ceiling are made from plexi glass to make it possible to videotape the subject.

Photo 2

Six magnets are fastened to each of the panels of plexi glass. They are used to attach the equipment in "The little Room". This means that several objects were fastened to the magnets by a piece of metal; 7 of the items were attached to the magnets by a 10 cm long string.

The reason for fastening the objects by magnets was to enable the child to take the objects down and possibly it would encourage the child to begin to search for an object after having let it go.

Only one of the infants was able to sit alone. "The little Room" for the others was built 30 cm high and 60 cm in breadth and depth. For the 20th infant "The little Room" was 60 cm × 60 cm × 60 cm.

The Equipment of "The little Room"

The toys in "The little Room" are shown on photo 3. 2.4

An embroidery ring (round frame used to hold sewing) was tied to the upper bar to the right of the infant. This ring was equipped with a square piece of greaseproof paper so that the paper within the ring was tight and the corners of the paper were outside the ring; this arrangement was intended to make it easy for the infant to grasp the paper. The string from the ring to the knot was 6 cm long and the ring was 18 cm in diameter.

Two plates were tied to the upper bar to the left of the infant. From the knot to the plates the string was 14 cm long and the plates were 14 cm in diameter. Near the edge of the two plates a hole was made so that the plates could be tied to each other with a bead in between; the bead was 1½ cm in diameter. The reason for this was to enable the infant to get his fingers and hand in between the plates and to grasp them. Neither the ring with greaseproof paper nor the plates could be removed but both of them could be turned around.

The three magnets in the back row of the ceiling held a bunch of shiny paper strips 25 cm long, to the right, in the middle a plastic tin with the opening towards the infant; to the left an inflated balloon with 2 beans inside.

The three magnets in the second row carried two metal teaspoons to the right, in the middle a small metal bell, and to the left two chinese rattles tied together. These rattles are plaited from rushes and have acute projections on the surface.

The three magnets in the third row held a metal key-ring with 4 metal-keys to the right; in the middle a rubber pad normally used beneath a cake of soap, the surface of this rubber pad also had acute projections; to the left there were two small boxes each of which measured 3 cm × 4 cm × 1½ cm, inside each box was a marble.

The magnets in the front row carried a plastic cup to the right, nothing in the middle, to the left a 35 cm long string with beads and rings.

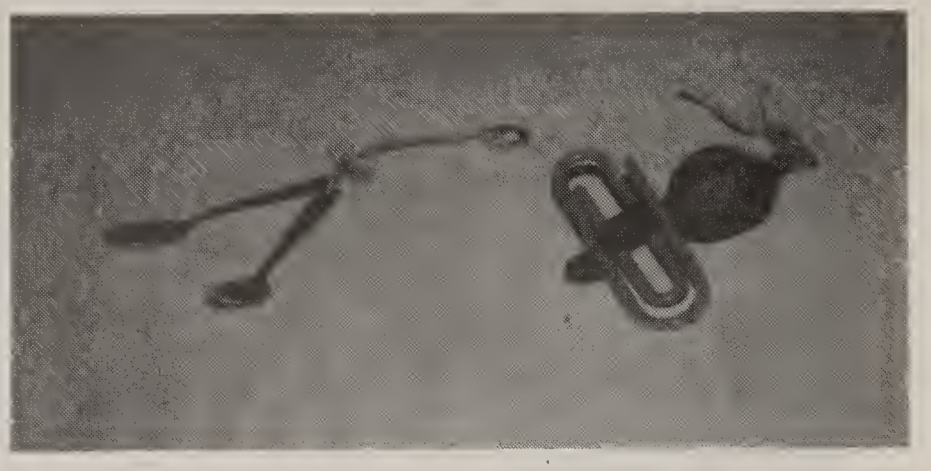
Photo 3

Keys

Beads and rings

Plastic tin

Rubber pad

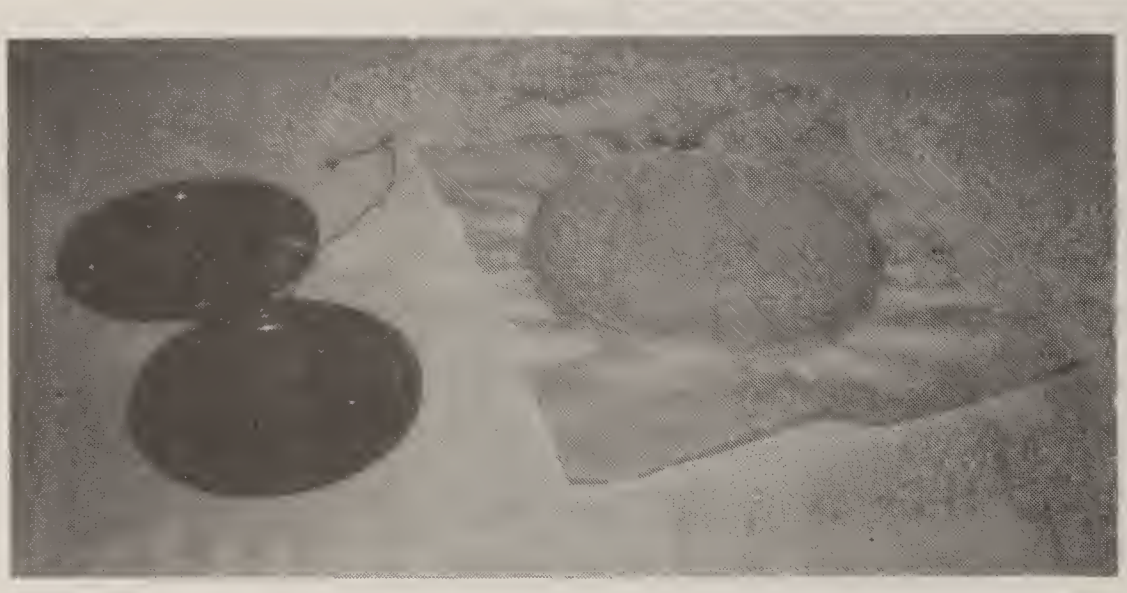


Teaspoons

Ballon

Small boxes

Rattles



Ring with greaseproof paper

Plates

Cup

Bell

Strips of shiny paper

The Rationale of the Objects

2.5

The objects were chosen to give the infant an opportunity to have different kinds of tactile and auditory experience. None of them had any special smell as it was not possible to bring in all the variables to this study.

The rattles, the greaseproof paper, the strips of shiny paper, the string with beads and rings and the boxes with marbles could give low frequency sounds but they had very different tactile qualities and different forms.

The balloon could give both low and high frequency sounds depending on how it was handled.

The rubber pad did not give much sound, but it had a strong tactile quality and it was possible to change its form.

The plates could also give low and high frequency sounds depending on how they were handled and their shape could be changed from convex-concave to convex or the opposite when one of the plates was turned; they could also be partly separated.

The teaspoon, the bell and the keys had high frequency sounds and the teaspoons and the keys could be taken apart and put together.

The plastic tin would give an echo effect if the infant vocalised towards it.

The same could be done with the cup. But the cup was also chosen because the infant was supposed to have some experience of cups. The sounds from the keys, teaspoons and the plates were thought to be familiar to the infants.

The string with beads and rings was chosen because the rings make it easy for infants to grasp and the length of it made it possible to make a sound with it towards the resonance-platform without doing anything else than pushing it.

The different objects were also chosen with the aim of giving the infant an opportunity to experience the different temperatures of objects. Equipped in this way "The little Room" was offered to all the infants.

The Control Environment

2.6 To compare the infant's performance in "The little Room" with their performance in another environment, the infants were offered the frame (Photo 4) of "The little Room", without the ceiling and walls.

Photo 4

The objects normally fastened on to the ceiling-panels were placed on 4 strings tied between the right and left upper bars. Magnets were attached to these strings to hold the objects.

The ring with greaseproof paper and the plates were removed when the infants were exposed to the frame.

The frame thus served as a control environment to "The little Room". This paradigm was chosen to compare the performance in "The little Room" with their performance in another environment which would be identical for all infants.

The environment the infants were normally exposed to would probably have been very different from each other, and it was thought to be too subjective to choose among the different ones in which an infant normally played. Comparison of activities in one of the infant's daily environments with activities in "The little

Room" would possibly have been too favourable for "The little Room". The frame equipped with almost the same objects was considered sufficient to ensure that the infant would show his capabilities and that any improvement that took place in "The little Room" could not be said to have occured only because the child was suddenly exposed to a situation much more stimulating than ever experienced before. Furthermore, the frame equipped with objects hanging over the infant was similar to the environment blind infants are normally exposed to, namely toys hanging over them in the perambulator, the bed and the play pen.

To compare different environments with "The little Room" was therefore considered as invalid in answering the question of which properties of "The little Room" would improve development of spatial relations.

Another reason for using the frame as a control environment was that appropriate observation tests adapted to congenitally blind infants are not available. Therefore it was impossible to get a valid assessment of the infant's capability to use as a measurement of possible improvement in "The little Room".

Thus, for several reasons, performance in the frame was considered as being the best possible control of performance in "The little Room".

Both the frame and "The little Room" were equipped in the same way for all infants at the beginning of all records.

Procedure

Since there are so few congenitally blind 6-18 months old infants it was not possible to get a control group of 20 other blind infants. Instead the infants were their own controls. They were divided into 4 groups, with 5 infants in each group. 2.7

The groups of infants were video recorded in the following way:

Group 6/2: 6 periods in the frame and 2 periods in "The little Room".

Group 4/4: 4 periods in the frame and 4 periods in "The little Room".

Group 2/6: 2 periods in the frame and 6 periods in "The little Room".

Group ½/8: 10 minutes in the frame and 8 periods in "The little Room".

Each recorded period was 20 minutes except for the infants in group ½/8 who were recorded for 10 minutes in the frame to see whether there was any difference in the way these infants reacted in "The little Room" compared with the frame.

Each period started with the infant lying on his back with most of his body inside "The little Room" or the frame. Only one of the infants was sitting.

To be sure that any improvement which may occur, was a result of exposing the infant to the experimental environment, and not from general development all 8 periods of video records took place for each of the 20 infants within 4-5 days of one week.

The infants were recorded just after having had a meal or just after waking from a sleep.

If the infant was unhappy in any way he was calmed before the record started. If the infant became unhappy within a period of recording he was given a break of a few minutes, enough to calm him.

Each infant was randomly selected for a group. Five descriptions of each of the four intended ways of exposing the infants respectively to the frame and "The little Room" were sealed in 20 blank envelopes (see Procedure, page 51). Just before the start of recording an infant, one of the envelopes was opened and the infant was then recorded according to the description enclosed. In that way the infant was recorded without any attention to possible additional handicaps.

None of the infants had experienced "The little Room" before the records took place. Neither had they participated in any other research-based investigation.

Scoring System

Chapter 3

The interpretation of the infant's acitivities was based on such reactions as alertness, surprise, disappointment, smiling, intensive listening, satisfied facial expression, babbling, shouting with joy, and the way the infant handled the objects.

To avoid giving scores for activities which were done unconsciously or quite accidentally, two conditions had to be fulfilled – the activity had to be repeated 5-6 times and the reaction of the infant had to present one of the above mentioned responses.

To assess the reaction of the infants a list of categories was elaborated. They were selected from the most common acitivities observed from the video records of all 20 infants – a total of 54 hours.

The categories were divided into three sections (see Table 4, page 58).

The first section of 3 categories (A1-A3) deals with activities of the hands with no object involved. The scores in this section make it possible to see whether or not the hands were occupied when the infant was not performing other acitivities.

The second section of categories is divided into 5 groups each of them dealing with spatially related activities according to the way these were performed.

The first group of 9 categories (B1-B9) deals with pre-kinesthetic activities, that is motor activities with objects and surroundings without any particular tactile or hearing reaction.

The second group of 7 categories (C1-C7) deals with tactile acitivities from just detecting tactile contact with something within reach to a more differentiated tactile search or searching which clearly showed that the infant was comparing his tactile experience.

The third group of 6 categories (D1-D6) deals with hearing. Giving a score to the category "react to self-produced sound" means that the infant clearly reacted to the sound, but it does not mean that he knew that he had actually produced it himself.

"Push objects making sound" means that the infant pushed the object and listened to the sound, but it does not mean that he knew that the sound was a result of his own activity.

"Rattle to produce sound" also means that the infant showed a listening attitude without knowing for certain that the sound was produced by himself.

"Grasp just after self-produced sound" means that the infant made a sound by, for example, pushing or touching an object, then listened and immediately grasped the object.

"Comprehend self-produced sound" means that the infant purposely made sounds with the objects or scratched for example, the Braille-plastic with reliefs and that the reaction of the infant clearly showed that he knew that the sound was made by himself. But it does not mean that the infant understood that all objects which make a sound can be reached for.

"Compare self-produced sound" means that the infant experimented by making different sounds with the same object or made a sound with 2 or more objects one after the other as if to compare the qualities of the sounds.

The fourth group of 5 categories (E1-E5) deals with even more conceptually and cognitively related activities. "Play sequence-game with 2 objects" means that the infant varied his play in an observable pattern with 2 objects placed in different positions in relation to his own body, or performed specific pattern with for example, the two plates. If the infant played such sequence-games with more than two objects the category for this was scored. If the infant was repeating a performed sequence-game after having been active in other ways the category "repeat sequence-game" was scored.

"Quantity-games" means that the infant was taking apart or putting together, for example, grasping all 4 keys and then using the other hand to move away the three keys one by one, or handling the teaspoons, the rattles or the small boxes in a way which showed that the infant was aware that there was more than one.

"Comparing games" means that the infant was playing 2 different games clearly to compare the activities either for their tactile or their sound qualities.

The fifth group of 4 categories (F1-F4) deals with understanding of the position of objects in the environment.

"Control by circular sweep of hand" means that the infant while occupied by an activity stopped for a second or two just to sweep his right or left hand around as if to control his surroundings.

"Tactile control of position of object" means that the infant touched an object while directing all his attention to this action to make sure that the object was still there.

"Comprehend position of certain object" means that the infant was quite sure of the position of an object he had been particularly interested in.

"Compare position of objects" means that the infant was touching several objects in succession in different directions comparing very precisely the position of the now familiar objects. This was interpreted partly from the way the infant grasped those objects with which they were playing experimental games, partly from the satisfied expression they displayed touching several objects in succession, and from the disappointed expression they dis-

played when an object had been taken down and was not any longer at the place where it had just been.

The third section of 2 categories (G1-G2) deals with temporary performance. This section was elaborated to see whether temporary elements are of importance for the infants.

"Repeat the same activity immediately" means that the infant let go of the object he was playing with just to touch or grasp it again repeating the game. "Interrupt activity for few seconds" means that the infant for a few seconds interrupted his game without letting go the object.

As the aim was to find out whether the infants, despite blindness were able to learn about spatial relations very early in life, much thought was given to the method of scoring.

All categories were examined in both the frame and "The little Room".

Scoring Categories Table 4

A 1: mouthing own hand
A 2: hand(s) contacting eye(s)
A 3: playing own fingers

B 1: grasp and let go object
B 2: grasp and keep object
B 3: mouthing object
B 4: move object from hand to hand
B 5: turn object using hands
B 6: tap object on own body
B 7: tap object on wall/platform
B 8: pick up object
B 9: pick up object just dropped

C 1: detect tactile contact of objects
C 2: recall tactile contact with objects
C 3: touch walls/ceiling
C 4: tactile search for dropped object
C 5: tactile search of details of object
C 6: tactile search of structure of walls
C 7: compare tactile experience

D 1: react to self-produced sound
D 2: push objects making sound
D 3: rattle to produce sound
D 4: grasp just after self-produced sound
D 5: comprehend self-produced sound
D 6: compare self-produced sounds

E 1: play sequence-game with 2 objects
E 2: play sequence-game, several objects
E 3: repeat sequence-game
E 4: quantity-games
E 5: comparing games

F 1: control by circular sweep of hand
F 2: tactile control of position of object
F 3: comprehend position of specific object
F 4: compare positions of objects

G 1: repeats the same activity immediately
G 2: interrupt activity for few seconds

Results

Tables 13-32 in the appendix (pages 101-120) show the scores for each of the infants.

The infants were different from each other both in age, motor development and in the way they reacted to the experimental environment. For each group some brief remarks are outlined about the performance of the infants.

Comments on Results of Infants in Group 6/2

All five infants received their scores in the frame within the first period. No improvement occured during subsequent stays in the frame.

Only one of the five infants, case no. 1, boy 11 months, 25 days (Table 13), improved during the 2 periods in "The little Room". During the time in the frame his only movements were to suck his hands and play with his fingers. As soon as he was placed in "The little Room" he became alert and began to move his arms, he stopped sucking and playing with his hands and fingers. He became surprisingly occupied with the objects, and as can be seen from his scores he learned that he was the one who produced the sound, and he began to control the position of objects. He received no score for "comprehend position of certain object", but he was very close to getting it.

Case no 2, girl 12 months, 23 days (Table 14), was occupied most of the time in performing specific movements in a very stereotyped way. All activities with objects were mouthcentered.

Case no 3, boy 14 months, 8 days (Table 15), was multiply handicapped. He was eager in trying to grasp but failed most of the time. Even though he reacted to the sounds he produced, he preferred to listen to sounds coming from other sources than from his own performance. The records had to be interrupted many times because he was unhappy. When he was happy he babbled and shouted with joy.

Case no 4, boy 7 months, 29 days (Table 16), was multiply handicapped and performed only a few movements other than sucking his hand. When he accidentally came into contact with an object, he reacted by withdrawing his hand immediately, as if he disliked the feeling. While motionless he listened intensely to every emerging sound. He preferred to be held in the arms of an adult.

Case no 5, girl 11 months, 4 days (Table 17), did not improve during the stays in "The little Room". She was the only one who was recorded sitting. While staying in the frame all her activities happened just in front of her. She was quite capable of picking up toys, turning them and searching for details, but only when the toys could be found just in front of her. When á toy fell next to her she made no effort to get hold of it again, she reacted to the sound from the fallen toy but she did not reach for it unless it fell between her legs. During her stays in "The little Room" she became perhaps a little more aware of the connection between dropping a toy and the sound from it, as she turned her head to the direction of the sound, but this reaction was not general enough to give her a score for "comprehending self-produced sound".

Comments on Results of Infants in group 4/4

4.2 In the frame the infants in this group were either totally passive or they received their scores within the first period. The improvement occured in "The little Room" and increased during the four periods.

Case no 6, boy 12 months, 22 days (Table 18), was totally passive during the periods in the frame. After 3 minutes in "The little Room" he began to move his head, then his arms and later on his legs. During the last but one period he was actively touching and pushing objects during all of the 20 minutes. During the last period he was active for 15 minutes. He became very aware of the sounds he was producing, and his facial expression became more and more alert. The parents said that they had never before seen their son being so active.

Case no 7, boy 13 months, 3 days (Table 19), improved remarkably in "The little Room" as he was totally absorbed in the activities he performed. He improved both in the field of tactile and auditory performance and even became able to compare positions of objects. He totally stopped sucking his hand and poking his eyes. The mother later told that the father had decided to make a "little room" for the boy, as he was no longer satisfied with traditional environments.

Case no 8, boy 9 months (Table 20), was unhappy with the unfamiliar environment. He preferred to be close to his mother, and she preferred to be the one who played with him. Each time he directed an object to his mouth she moved the object away. When

he seemed to be absorbed in a game in "The little Room" she wanted the record interrupted.

Case no 9, boy 6 months, 3 days (Table 21), improved remarkably. Already during the first period in "The little Room" he began to be interested in the two plates hanging on the wall to his left. In the last period he played with the plates during the whole 20 minutes – he experimented with making different sounds with them and changing their form by turning them and by taking them apart, he even grasped the plates with both hands. After the end of this last experimental period he stayed in "The little Room" and continued the experimenting game for a further 35 minutes, after which he was still interested but tired. As he is 12 weeks premature it is remarkable for such a young infant to concentrate in an experimenting game for such a long time.

Case no 10, boy 14 months, 20 days (Table 22), was unable to grasp, but during the periods in "The little Room" he became very much aware of the sounds he made by pushing the objects and came close to getting a score for "comprehend self-produced sounds".

Comments on Results of Infants in Group 2/6

All the infants in this group also scored for performance in the frame within the first period. Improvement happened during the periods in "The little Room".

Case no 11, girl 11 months, 7 days (Table 23), learned that she was the producer of the sounds and she became very sure of the positon of the objects unless she dropped them. When she lost an object, she reached precisely in the direction where she had found it before she removed it from the magnet, and she reacted with a disappointed facial expression when the object was no longer where it had just been. She was intensely active, exploring details of objects and playing sequence-games. Now and then she babbled and shouted with joy.

Case no 12, girl 5 months, 14 days (Table 24), who was the youngest participant in the study also improved in "The little Room" as she began to react to the sounds she was producing and to perform tactile control of the position of objects within her reach.

Case no 13, boy 9 months, 3 days (Table 25), became more and more aware of the sounds he produced, and he began to expe-

riment by making different sounds with the objects. When this was established, he began to be interested in the tactile properties of the environment, but not enough to get any score for tactile search.

Case no 14, girl 8 months, 20 days (Table 26). In the last but one period she performed tactile control of the position of objects in a remarkable way. While very absorbed in searching for details of an object she occasionally reached for other objects, just to touch them as if to ensure that they were still where she supposed them to be.

Case no 15, boy 12 months, 24 days (Table 27). The improvement during the period in "The little Room" for this boy was specifically in the auditory area. He became quite sure that he was producing the sounds from objects. He listened motionless until the sound stopped, after which he repeated making the sound. He totally stopped playing with his fingers.

Comments on Results of Infants in Group ½/8

4.4 As the infants from this group only stayed in the frame for 10 minutes, they perhaps showed some of their already acquired capability within the first period in "The little Room". Nevertheless, the improvement which occured grew during the periods in "The little Room".

Case no 16, boy 8 months, 10 days (Table 28), began to move objects from hand to hand and became quite occupied mouthing objects and taking apart and putting together the keys as well as performing tactile search of details of objects.

Case no 17, boy 16 months, 23 days (Table 29). In spite of poor gross motor development he searched for every little detail of all the objects. He improved remarkably within the auditory area. In the last but one period he began to babble and to experiment with his vocalisation. The parents said that he had not babbled at all since he stopped at the age of 2-4 months.

Case no 18, girl 15 months, 11 days (Table 30), became very active. She improved in all areas, but all her activities were performed with one hand at a time, she did not show any midline organization of the hands.

Case no 19, girl 19 months, 15 days (Table 31), played with her fingers in a sterotyped way but still improved. In the beginning she

grasped objects, then she learned that she was the sound-producer, and lastly she learned about the position of the objects.

Case no 20, boy 8 months, 1 day (Table 32), became very occupied with the objects. In the beginning he only played for a few seconds with an object, but then he began to experiment with the sounds he was producing, for example, purposely making gross or fine movements to make different sounds with the object involved. During all the different games he performed he occasionally stopped the activity for 1-3 seconds as if to listen to the silence arising from his inactivity. In the last period he tapped one object towards another several times in succession. The first day of recordings the mother said: "The problem is that he cannot play on his own". The last day she said: "How could I satisfy him tomorrow?" (She was given some suggestions).

Stages of Improvement

In the frame most of the infants performed already acquired primitive spatially related activities. During stays in "The little Room" fifteen of the infants acquired more conceptual spatial relations. The improvement occured gradually. Improvement means that the infant during the periods in "The little Room" performed spatially related activities which were more advanced than those performed during periods in the frame or during the first one or two periods in "The little Room", for example, advancing from detecting tactile contact of objects to performing tactile search of details of an object, or advancing from reacting to self-produced object-based sounds to understanding oneself as the producer of such sounds.

Some general developmental stages were observed from the 54 hours of video records. In the following the generalities are outlined as a rough guide.

The first stage was accidental movements with the result that the infant began to be aware of the objects hanging from the ceiling.

The second stage was conscious pushing or touching of objects.

The third stage was grasping and letting go, followed by grasping and keeping objects.

The fourth stage was immediate repetition of an activity. The first time the infant happened to repeat an activity he immediately

reacted with surprise. When repetitions had been performed several times his reactions became more acknowledged – he smiled, babbled or had an excited facial expression. Then repetitions were clearly performed with the aim of repeating a tactile or an auditory experience, or to recognize a specific object in a specific direction.

The fifth stage was varied handling of an object. Some of the infants became very absorbed in performing tactile exploration and did not react at all to the sounds they produced concomitantly. Thus they started to integrate kinesthetic and tactile sense modalities. Other infants started with integration of the kinesthetic and auditory senses; for example they experimented with discovering which auditory result they could get from a slow or quick performance of the same movement with the object involved. While exercising kinesthetic-auditory integration they did not display tactile interest.

The sixth stage was to listen at the same time as performing a kinesthetic-tactile activity or to begin to perform tactile search of the object with which a kinesthetic-auditory game was displayed. Thus, when either kinesthetic-tactile or kinesthetic-auditory integration had become familiar further integration of sense modalities became possible.

The seventh stage. While displaying tactile search of one object the infants performed a quick search of another object, clearly to compare the tactile qualities. The infants also performed different sounds with the same object or with two objects to compare the sounds. They performed a quick touch or grasp of several objects one after another as if to compare the position of the objects, or to assure themselves of the presence of the objects. Their reaching for objects in a specific direction and position became unexpectedly precise.

Within this stage of improvement the infants also began to play games which involved a sequence of specific actions, for example, alternately manipulating the spoons and pushing the keys towards the cup or to repeatedly handling 3 or 4 objects in the same range. Sometimes a sequence-game was displayed for 1-2 minutes, sometimes for 3-4 minutes, but if the infant became very involved the game could continue for nearly a full period.

During these stages 11 of the infants (cases no 1, 7, 9, 11, 13, 14, 15, 17, 18, 19, 20) learned that they were the producers of the

emerging sounds. Nine of these infants also learned very precisely where to find a specific object.

Other Specific Observations

Handling of objects.

Half of the infants never performed midline organization of their hands. Only 2 infants learned to move an object from hand to hand. In the beginning most of the infants used their left hand only when performing kinesthetic-tactile or kinesthetic-auditory activities; later on some of them began to use their right hand only, and a few began to alternate between left or right hand. 4.6

Listening

In spite of blindness several of the infants clearly reacted with awareness the first time "The little Room" was placed over them. They stiffened their body for a second or two, whereupon they waved their hands or moved their feet and had an excited facial expression. This reaction was not seen when the frame was placed over them.

During periods in the frame most of the infants listened to all the sounds emerging from the outside world, from doors, the telephone, the washing-machine and so on. While in "The little Room" the infant did not react to such sounds, instead they began to listen to the sounds emerging from their own activities.

Object preference

Most of the infants showed preference to specific objects and to specific activities. Objects with acute points were more interesting than objects with a more smooth surface, and those whose form could be changed were more interesting than more stable objects. Objects which could be taken apart received much attention from the infants.

During the first stages of improvement the infants seemed to prefer objects with low frequency sounds while high frequency sounds were enjoyed later on.

Activity preference

Preferred activities were tactile and auditory experiments and comparing tactile or auditory experience. The tactile activities

were mostly performed with the keys, the rattles, the small boxes and the rubber pad. The auditory activities were mostly performed with the plates, the spoons, the rattles and the ring with greaseproof paper.

Discussion

Chapter 5

The aim of the study was to investigate whether a specially designed experimental environment would facilitate the achievement of early spatial relations and to observe which properties of this environment would improve the development of spatial relations very early in the life of the congenitally blind infant.

In the way the study was designed it was expected that if "The little Room" had any effect on the infants' reaching and spatially related activities and games, it would be most pronounced in the infants who stayed in "The little Room" during 8 periods.

The Effect of "The little Room"

5.1

A survey of the results are shown in Tables 5-12. Table 5 shows the total scores for activities involving spatial relations for all 20 infants. The result supports the hypothesis that "The little Room" is of benefit for congenitally blind infants in facilitating their ability to perform spatially related activities and to improve within this field of development.

Table 5

Activities Involving Spatial Relations: Total Scores for all 20 Infants

	The Frame	*The little Room*
Spatially related activities	101	310

The improvement was significant at p. < 0,6 %
(Kendall's test).

Because of the small number of infants statistical analysis of the results shown in Tables 7-12 was not possible.

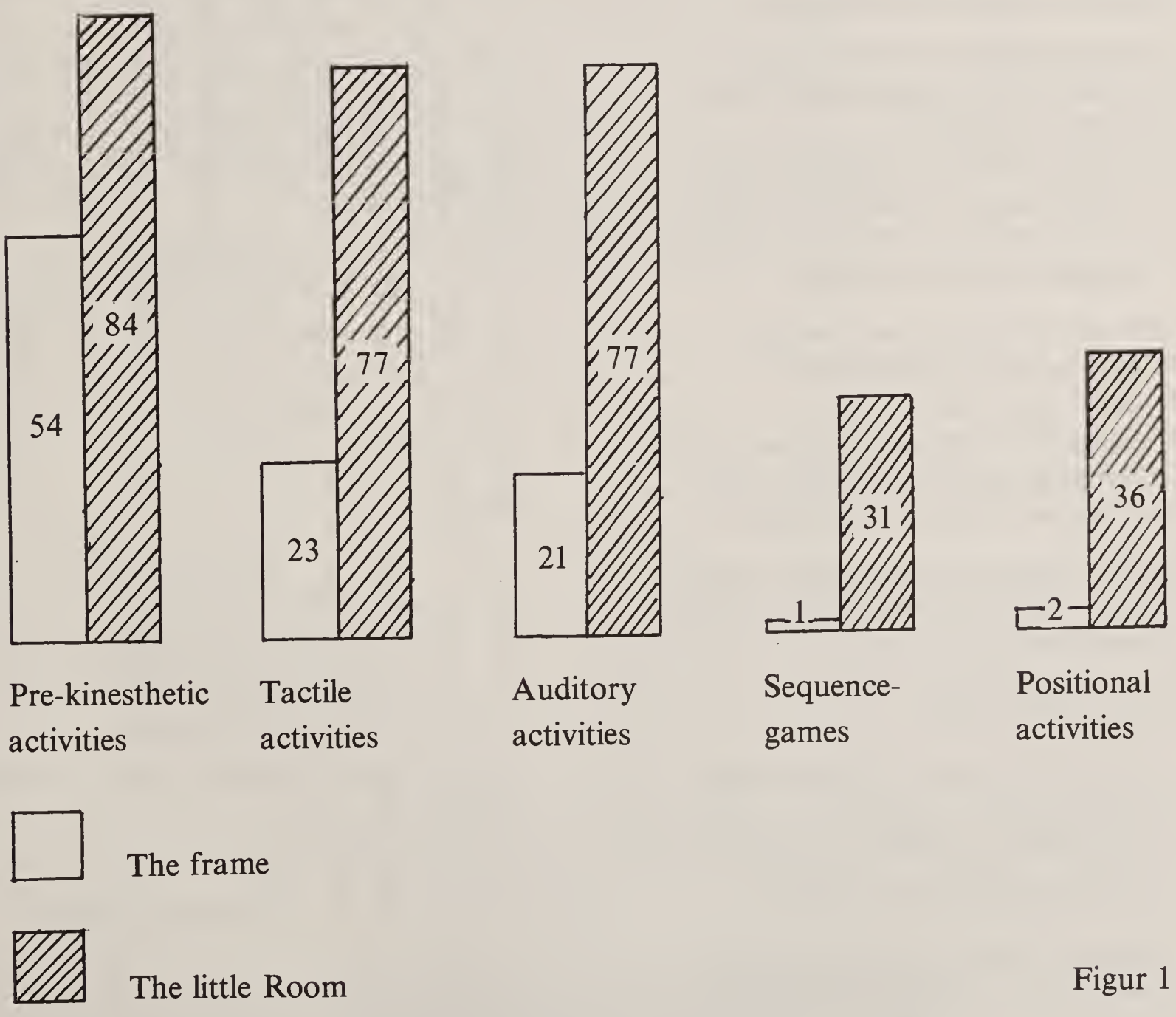
Figure 1 (page 67) shows a diagram of the total scores for spatially related activities in the frame and "The little Room".

Table 6 (page 68) shows the total scores for each category for each group.

Table 7 (page 69) shows the scores for activities involving spatial relations for each of the infants from periods in the frame and "The little Room" respectively.

All but one of the infants of the groups who stayed in "The little Room" during 4, 6 and 8 periods of 20 minutes improved in performing spatially related activities. Of the infants who only stayed in "The little Room" for 2 periods of 20 minutes, only one improved.

Diagram of Total Scores for Spatially Related Activities in the Frame and "The little Room"



Figur 1

All Groups: Total Scores for Each Category for Each Group in The Frame and "The little Room" Table 6

	6/2		*4/4*		*2/6*		*½/8*		*Total*	
	F	*R*	*F*	*R*	*F*	*R*	*F*	*R*	*F*	*R*
A 1: mouthing own hand	4	3	3	2	2	1	1	1	10	7
A 2: hand(s) contacting eye(s)	1	1	2	1	1	1	0	0	4	3
A 3: playing own fingers	3	1	0	0	3	1	2	2	8	4
B 1: grasp and let go object	3	4	2	3	5	5	3	5	13	17
B 2: grasp and keep object	2	3	1	3	5	5	3	5	11	16
B 3: mouthing object	2	2	2	4	4	5	0	1	8	12
B 4: move object from hand to hand	2	2	1	1	3	3	1	3	7	9
B 5: turn object using hands	2	2	0	1	2	2	0	2	4	7
B 6: tap objects on own body	0	0	1	0	1	3	0	2	2	5
B 7: tap object on wall/platform	0	1	0	1	2	4	0	2	2	8
B 8: pick up object	1	1	2	2	1	1	1	2	5	6
B 9: pick up object just dropped	1	1	1	2	0	0	0	1	2	4
C 1: detect tactile contact of objects	4	5	4	5	4	5	3	5	15	20
C 2: recall tactile contact with object	1	1	0	3	1	5	1	5	3	14
C 3: touch walls/ceiling	0	3	0	5	0	5	0	4	0	17
C 4: tactile search for dropped object	0	0	0	1	0	0	0	1	0	2
C 5: tactile search of details of object	1	2	0	2	1	2	1	3	3	9
C 6: tactile search of structure of walls	0	1	0	1	0	1	0	1	0	4
C 7: compare tactile experience	1	2	0	3	1	3	0	3	2	11
D 1: react to self-produced sound	4	5	2	5	3	5	2	5	11	20
D 2: push objects making sound	0	2	1	4	3	5	2	5	6	16
D 3: rattle to produce sound	0	1	1	3	2	3	1	3	4	10
D 4: grasp just after self-produced sound	0	1	0	2	0	4	0	4	0	11
D 5: comprehend self-produced sound	0	1	0	2	0	4	0	4	0	11
D 6: compare self-produced sounds	0	0	0	2	0	3	0	4	0	9
E 1: play sequence-game with 2 objects	0	1	0	3	0	3	0	4	0	11
E 2: play sequence-game, several objects	0	0	0	1	0	3	0	1	0	5
E 3: repeat sequence-game	0	1	0	2	0	3	0	4	0	10
E 4: quantity-games	0	0	0	0	0	1	0	2	0	3
E 5: comparing games	1	1	0	1	0	3	0	2	1	7
F 1: control by circular sweep of hand	0	0	0	1	1	5	0	4	1	10
F 2: tactile control of position of object	0	1	0	3	1	4	0	3	1	11
F 3: comprehend position of specific object	0	0	0	2	0	3	0	4	0	9
F 4: compare positions of objects	0	0	0	1	0	2	0	3	0	6
G 1: repeat same activity immediately	1	4	0	5	3	5	0	5	4	19
G 2: interrupt activity for few seconds	0	0	0	2	2	5	1	5	3	12

Activities Involving Spatial Relations: Scores for Each Infant in the Frame and "The little Room" Table 7

Case no.		*The Frame*	*The little Room*
	Group 6/2		
1*	Boy, 11 mo. 25 d.	0	11
2	Girl, 12 mo. 23 d.	7	8
3*	Boy, 14 mo. 8 d.	3	4
4*	Boy, 7 mo. 29 d.	2	2
5	Girl, 11 mo. 4 d.	13	19
	Scores	25	44
	Group 4/4		
6*	Boy, 12 mo. 22 d.	0	5
7	Boy, 13 mo. 3 d.	8	27
8	Boy, 9 mo. 0 d.	6	10
9	Boy, 6 mo. 3 d.	1	19
10*	Boy, 14 mo. 20 d.	3	8
	Scores	18	69
	Group 2/6		
11	Girl, 11 mo. 7 d.	12	27
12	Girl, 5 mo. 14 d.	5	11
13	Boy, 9 mo. 3 d.	8	21
14	Girl, 8 mo. 20 d.	11	23
15*	Boy, 12 mo. 24 d.	4	18
	Scores	40	100
	Group ½/8		
16	Boy, 8 mo. 10 d.	3	13
17*	Boy, 16 mo. 23 d.	7	27
18*	Girl, 15 mo. 11 d.	0	18
19*	Girl, 19 mo. 15 d.	3	16
20	Boy, 8 mo. 1 d.	5	23
	Scores	18	97

* mentally retarded

Two infants (10 % of the total records) were randomly selected to be reviewed by my colleague Birgit Petersen. Our assessments differed in a few categories only. The differences were discussed and found to be a question of whether an activty was performed often enough to a give a score.

Results of the Different Spatially Related Activities

5.2 Table 8 (page 71) deals with the performance of pre-kinesthetic, tactile and auditory activities, sequence-games and positional activities.

Pre-kinesthetic Activities

5.2.1 Where pre-kinesthetic activities are concerned, it should be kept in mind that scores in this field mean that the infant performed motor activity without any specific tactile or auditory reaction. The infant improved in performing motor skills both in the tactile and auditory fields, as well as in the field of sequence-games and positional activities. This happened as an integration of kinesthetic-tactile or kinesthetic-auditory modalities. A few seemed to be capable of kinesthetic-tactile-auditory integration.

The infants were very different in their performance of pre-kinesthetic activities. Both in the frame and "The little Room" two infants (cases no 4 and 10) were unable to perform pre-kinesthetic activities. Six infants (cases no 2, 3, 8, 12, 13, 14) received the same scores in the frame as in "The little Room".

The improvement in 6 infants from group 6/2, 4/4 and 2/6 (cases no 1, 6, 7, 9, 11, 15) was probably due to "The little Room" as the reaction of these infants to "The little Room" was quite different from their reaction to the frame. These reactions are discussed in chapter 5.4.

All infants from group ½/8 improved during stays in "The little Room", 3 of the infants (cases no 17, 18 and 20) reacted to "The little Room" with a high degree of excitement.

The improvements which occured in pre-kinesthetic performance were almost the same as those observed in the past in mentally retarded infants and children who were placed on the resonance-platform. But in "The little Room" the improvement occured much faster and the influence on the development of integration of sense modalities was of quite another quality than that obtained from the resonance-platform.

Tactile and Auditory Activities

5.2.2 During periods in "The little Room improvement in tactile and auditory activities occured in all groups. Where tactile activities

are concerned, performance in the frame was almost the same for all groups; 2 and 4 periods in "The little Room" resulted in improvement, while 6 or 8 periods did not improve the performance found after 4 periods.

Scores for auditory activities in the frame were almost the same for all groups. Improvement occurred for all groups in "The little Room", specifically when the infants were exposed to it for more than 2 periods.

Sequence-games and Positional Activities

5.2.3

Periods in the frame did not encourage the infants to play sequence-games or to perform positional activities.

At least 4 periods of experiencing "The little Room" seemed to be necessary before the playing of sequence-games and the comprehension of position of specific objects began. The more time the infants spent in "The little Room" the more they improved in both sequence-games and positional activities, and the improvement within these fields was almost the same. Some degree of knowledge within the tactile and auditory fields was necessary for improvement in the fields of sequence-games and positional activities.

Scores for Various Fields of Spatial Activities

Table 8

		6/2		*4/4*		*2/6*		*½/8*		*Total*	
		F	*R*	*F*	*R*	*F*	*R*	*F*	*R*	*F*	*R*
B1-B9:	Pre-kinesthetic activities	13	16	10	17	23	28	8	23	54	84
C1-C7:	Tactile activities	7	14	4	20	7	21	5	22	23	77
D1-D6:	Auditory activities	4	10	4	18	8	24	5	25	21	77
E1-E5:	Sequence-games	1	3	0	7	0	13	0	13	1	36
F1-F4:	Positional activities	0	1	0	7	2	14	0	14	2	36
	Total	25	44	18	69	40	100	18	97	101	310

Brief Summary of General Results

5.2.4 The hypothesis that "The little Room" is of benefit for congenitally blind infants in learning early spatial relations was supported by the result. Where the total scores for all infants are concerned the improvement was significant at p. < 0,6% (Kendall's test). Pre-kinesthetic performance was effected by "The little Room" in 9 infants, 3 improved either due to time or "The little Room", while neither time nor "The little Room" affected the pre-kinesthetic performance in 8 infants. Both "The little Room" and the time spent there influenced tactile and auditory improvement. Improvement in tactile and auditory activities was necessary before sequence-games and positional activities were played.

The Effect of Impairment, Sex and Age on Performance

5.3 Table 9 shows the result for mentally retarded infants compared with infants who were blind only. Table 10 deals with the results for female and male infants respectively. Table 11 deals with the results for infants who were younger than 10 months and those who were older.

Mentally Retarded Infants

5.3.1 Of the 15 infants who improved considerably during stays in "The little Room" 7 were mentally retarded. Of the 5 infants who did not improve significantly 2 were mentally retarded. This means that mental retardation should not be considered as the only reason for delay in understanding spatial concepts. Lack of appropriate stimulation very early in life may be responsible for some of the delay in blind, mentally retarded infants, and probably also for the delay in some blind infants without additional impairments.

Table 9 shows that the improvement for the mentally retarded infants compared with the infants who were only blind occurred specifically in the pre-kinesthetic field.

During periods in "The little Room" the mentally retarded improved in all fields; they needed more time in "The little Room" than the infants who were blind only, but as a whole the mentally retarded improved more than the infants who were blind only.

"The little Room" and the time spent there were so important for the mentally retarded infants' improvement in spatial relations that all blind, mentally retarded infants in the future should be given the opportunity to perform activities in a specific environment such as "The little Room".

Further investigations are needed to determine how early understanding of spatial relations would influence later development in mentally retarded blind children.

Scores for Infants Mentally Retarded or Blind Only

Table 9

	6/2		*4/4*		*2/6*		*½/8*		*Total*	
	F	*R*	*F*	*R*	*F*	*R*	*F*	*R*	*F*	*R*
Nine Mentally Retarded Infants										
B1-B9	1	3	0	1	2	5	4	14	7	23
C1-C7	2	7	1	5	0	3	4	12	7	26
D1-D6	2	6	2	4	2	6	2	17	8	33
E1-E5	0	0	0	2	0	2	0	8	0	12
F1-F4	0	1	0	1	0	2	0	10	0	14
Total B-F	5	17	3	13	4	18	10	61	22	109
Eleven Infants Only Blind										
B1-B9	12	13	10	16	21	23	4	9	47	61
C1-C7	5	7	3	15	7	18	1	10	16	50
D1-D6	2	4	2	14	6	18	3	8	13	44
E1-E5	1	3	0	5	0	11	0	5	1	24
F1-F4	0	0	0	6	2	12	0	4	2	22
Total B-F	20	27	15	56	36	82	8	36	79	201

Group 6/2 consisted of 3 mentally retarded and 2 infants blind only.
Group 4/4 consisted of 2 mentally retarded and 3 infants blind only.
Group 2/6 consisted of 1 mentally retarded and 4 infants blind only.
Group ½/8 consisted of 3 mentally retarded and 2 infants blind only.

Female and Male Infants

5.3.2 Table 10 shows the improvement for female and male infants. While in the frame the male infants were not as capable as the female infants in pre-kinesthetic and tactile activities, but in "The little Room" the male infants improved as much as the female infants in the pre-kinesthetic field and more than the female infants in the tactile field.

As soon as the male infants had improved in the pre-kinesthetic field they very quickly made use of the tactile properties of the objects. Pre-kinesthetic development may be considered as necessary to obtain tactile inputs.

When kinesthetic-tactile integration was established both sexes improved similarly in the auditory field and in the fields of sequence-games and positional activities.

Table 10

Spatially Related Activities for 7 Female and 13 Male Infants

	The Frame	*The little Room*
Females, B1-B9	29	39
Males, B1-B9	25	45
Females, C1-C7	12	27
Males, C1-C7	11	50
Females, D1-D6	7	27
Males, D1-D6	14	50
Females, E1-E5	1	14
Males, E1-E5	0	22
Females, F1-F4	2	15
Males, F1-F4	0	21
Total for 7 female infants	51	112
Total for 13 male infants	50	188

Influence of Age

5.3.3

At least 4 periods in "The little Room" seemed to be necessary for improvement in spatial relations. Table 11 shows the scores for infants younger and older than 10 months of age from the groups 4/4, 2/6 and ½/8 respectively. The result shows that infants older than 10 months improved only a little more than those younger than 10 months.

This means that early improvement in spatial relations is possible and that the older infants may be considered delayed within this field.

Infants Younger and Older than 10 Months of Age

Table 11

			The Frame	*The little Room*
Infants Younger than 10 Months of Age				
Group 4/4	Male	9 mo. 0 d.	6	10
	Male	6 mo. 3 d.	1	19
Group 2/6	Female	5 mo. 14 d.	5	11
	Male	9 mo. 3 d.	8	21
	Female	8 mo. 20 d.	11	23
Group ½/8	Male	8 mo. 10 d.	3	13
	Male	8 mo. 1 d.	5	23
		Total	39	120
Infants Older than 10 Months of Age				
Group 4/4	Male	12 mo. 22 d.	0	5
	Male	13 mo. 3 d.	8	27
	Male	14 mo. 20 d.	3	8
Group 2/6	Female	11 mo. 7 d.	12	27
	Male	12 mo. 24 d.	4	18
Group ½/8	Male	16 mo. 23 d.	7	27
	Female	15 mo. 11 d.	0	18
	Female	19 mo. 15 d.	3	16
		Total	37	146

Brief Summary of Different Factors Affecting Performance

5.3.4 Mentally retarded infants improved but needed more time in "The little Room" than the infants who were blind only.

"The little Room" helped the male infants improve in pre-kinesthetic activities, whereby they improved to the same level as the female infants in the remaining fields.

Infants younger than 10 months of age improved almost as much as those older than 10 months of age.

Comments on Stimuli in "The little Room"

5.4 As both the frame and "The little Room" consisted of equipment which enabled the infant to obtain tactile and auditory knowledge, play sequence-games and perform positional activities, the reason for the evident improvement which occured during stays in "The little Room" must be considered from different aspects.

Echoes

5.4.1 Bower (1977) stated that very young blind infants are probably able to benefit from echoes. Bower also noticed the difficulties blind infants have in benefitting from echoes in traditional environments where many sounds are emerging, and where carpets and curtains absorb the echoes.

It would appear that the echoes of "The little Room" had some significance. In comparison with their reaction in being placed in the frame some of the infants became very excited from the very first second in "The little Room". The excitement involved waving arms and hands and turning the head. These movements resulted in unintentional contact with the objects hanging from the ceiling. This effect probably encouraged further movements.

Making a sound during stays in "The little Room", by pushing objects or by babbling, also produced excitement in the infant. In some cases this seemed to result in experiments with the echoes. Holt (1979) noticed that auditory perception from a distance does not develop in normal infants until they are mobile.

In "The little Room" the echoes from every emerging sound were occurring close enough to the infant so that he could hear

them. Perhaps the echoes had a reinforcing effect upon the infants interest in further exploration and examination of his surroundings.

Elimination of Sounds

5.4.2

"The little Room" seemed to eliminate all sounds from the outside world, at least enough to give the infant a better opportunity to concentrate on their acitivities. While in "The little Room" none of the infants reacted to sounds from the outside.

While in the frame most of the infants reacted to all emerging sounds. Sounds from the outside world are assumed to be unintelligible for a blind infant so that he never knew whether a sound meant that someone would come and pick him up, or that he would be interrupted in what he was doing, or that the sound would just cease. The fact that the infants became motionless (see chapter 5.5.3) while listening was in itself an interruption of their activities.

The Absence of Interference

5.4.3

The fact that there was no interference by anyone while the infant was video recorded was probably also important. Nobody talked to the infant, made sound with or moved any of the objects that were in the frame and "The little Room". While in "The little Room" where sounds from the outside world were eliminated the experience of absence of interference was complete, which probably reinforced the perception of connection between the infant's movements and the space represented by "The little Room". The absence of interference gave the infant a real opportunity to decide when and for how long he wanted to be active with the objects around him and to choose which kind of activity he would prefer.

Stability of the Environment

5.4.4

Each time the infant was offered "The little Room" the equipment in it was the same. This means that as long as the infant was unable to or did not remove the objects from the magnets he experienced specific results according to the direction of his movements. The feedbacks were stable, and having the same feedback

from the same movement over and over again resulted in recognition of the feedback. In this way movement in all directions became important with improvement as a result. Improvement and the stability of the environment enabled the infant to display comparisons of tactile and auditory experiences and to play sequence-games.

For the infants who were able to remove the objects from the magnets "The little Room" was less stable. However, when these infants became interested in tactile and auditory experiments they either used a removed object for some purpose or they handled the object without removing it.

Comments on Specific Fields

5.5 Table 6 (page 68) shows the total scores for each category for each group.

Pre-kinesthetic Activities

5.5.1 In the frame 8 infants were mouthing objects while 12 were doing so in "The little Room". Seven infants moved objects from hand to hand in the frame, while 9 infants did so in "The little Room"; 4 turned objects using their hands in the frame and 7 learned to do so in "The little Room".

Thus, the infants did not improve much in midline organization. Some of the infants tried to use both hands at the same time, but either they let go of the object before succeeding in grasping with the other hand, or the string tied to the object was too short to let the infant successfully move the grasped object to the other hand.

Further investigation must be carried out to determine whether another way of equipping "The little Room" would facilitate midline organization of the hands. In the frame only 5 infants were able to pick up dropped objects – just one more infant was able to do so while in "The little Room".

In the supine position the infants seemed to be unaware of objects that had fallen next to their head, even though they had previously touched or pushed the same things. They were more aware of objects that had fallen next to their hips. Objects which were picked up were mostly taken from a position next to the hips of the infant.

The inside of the hand is more sensitive to touch than the outside. As long as the infant is unable to rotate his hand, the upper side of the hand will meet objects which have fallen next to his head, while the inside of the hand is more liable to meet objects next to his hips.

Several authors (Fraiberg, 1977; Bower, 1977; Burlingham, 1972; Davidson et al., 1984; Elonen et al., 1964; Warren, 1984) mention the general passivity and inactivity of the hands of blind infants.

Although the 15 infants who improved during stays in "The little Room" had difficulty learning to use both hands at the same time, and picking up dropped toys, the infants were seldom observed with inactive hands.

That "The little Room" could provoke movements and sustained activity must probably be seen from the different aspects discussed in chapter 5.4.

Activities within the pre-kinesthetic field seemed to start improvement in other areas for both the mentally retarded infants and for the very young infants who were only blind (6 months, 3 days, Table 21, 8 months, 10 days, Table 28 and 8 months, 1 day, Table 32 – respectively 12, 12 and 14 weeks premature). This supports the hypothesis of Jones (1975) that all spatial distinctions are founded upon voluntary movements, i.a. movements that are unrestricted as defined in chapter 1.5. It also supports the suggestion of Tobin (1980) that awareness of external objects depends on adequate feedback from preliminary movements.

Tactile Activities

5.5.2

In the frame only 3 infants recalled tactile contact with objects, while 14 were doing so in "The little Room". In the frame 3 infants used tactile search to find details of objects, while this became general for 9 infants in "The little Room". Only 2 infants compared tactile experience in the frame, while 11 were doing so in "The little Room".

Some of the improvement in this field may be due to previous development in the pre-kinesthetic field.

Another reason may be that all sounds from the outside world were eliminated enough to enable the infant to concentrate on the happenings inside "The little Room".

1. Tactile search. The infants were particularly interested in touching objects with acute points or different surfaces. Tactile search of objects with a smooth surface was discontinued very quickly.

The discrepancy hypothesis (McCall & Kagan 1967 a, b) suggests that stimuli which represent a moderate degree of discrepancy from an existing schema will recruit maximal attention, whereas those that are either very similar to, or exrermely discrepant from the schema will recruit minimal attention.

Is this hypothesis also relevant for blind infants?

Blind infants have to play with objects given to them by other people. Because of lack of sight they are unable to demonstrate their interest in specific objects either by pointing or by looking. Unless a sufficient number of different objects with various properties are present very near them, they are unable to choose objects with discrepancies fitting for the scheme already established.

Experience from working daily with blind infants and children show that the toys and objects chosen for their visual qualities look moderately different, but from an auditory and tactile point of view they are often either minimally or extremely different from one another.

But what do blind infants need?

The obvious preference for specific objects in "The little Room" showed that tactile search was encouraged by a high degree of tactile discrepancy within a single object, for instance the rattles and the rubber pad, while comparisons of details in two objects were merely done with objects of moderate tactile discrepancy, such as comparing the keys with the spoons.

More investigations are needed to determine which properties of objects would produce maximal attention in the blind infants.

2. Tactile comparisons. The relative stability of "The little Room" and the equipment with objects of different tactile quality encouraged the infants to perform tactile comparions. In the frame 2 infants performed tactile comparisons while 11 infants did so in "The little Room". As well as comparisons of tactile details of two objects, the infant also performed tactile comparisons by touching several objects one after another. These actions seemed to affect the understanding of the position of objects.

Auditory Activities

Specific improvements occured within the categories D 4, D 5 and D 6, grasping just after self-produced sound, comprehending and comparing self-produced sounds respectively. In the frame none of the infants received scores on these categories. In "The little Room" 11 infants began to grasp just after producing an object-based sound, 11 learnt that they were the producers of such sounds, and 9 began to compare self-produced sounds.

The observation that blind infants are totally motionless while listening has been mentioned by several authors (Fraiberg, 1977); Burlingham, 1972; Sonksen, 1979).

During periods in the frame the infants in this study were also immobile while listening, but during the first period in "The little Room" their listening attitude became more differentiated. While listening they turned their head slightly towards the direction of the sound they had just produced with the toys. When the sound ceased they began to move their arms and legs again. When the movements resulted in sound from an object, they again stopped all other movements, but turned their head towards the sound. During the following periods they began to grasp or push just after producing an object-based sound.

They also began to experiment with making these sounds. After making a sound they stopped the movement, and listened until the sound ceased. Then they repeated the same sound or they made another sound with the same or another object. During these experiments their facial expression clearly showed that they now knew that the sounds were made by themselves. Later on they were able to listen and handle the object simultaneously.

To understand oneself as the one who produces an object-based sound means that the infant can relate the auditory experience to his own activity, and that he can control the length of time of the sound. Such knowledge may constitute a contrast to his experience of sounds from the external world; sounds which emerge and stop without any relation to his own activities (see Chapter 1.1.1, 1.1.2 and 1.1.4).

Maybe understanding of oneself as the one who makes the sounds with objects is necessary to integrate kinesthetic and auditory sense modalities.

However, the elimination of sounds from the outside world seemed to be of importance also for auditory activities. Sounds occuring inside "The little Room" were always made by the infant, so the infant could learn and understand that he was the sound-producer.

The youngest of the 11 infants who learnt that they were the producers of the emerging sounds while in "The little Room" were 6 months 3 days old, 9 months 3 days old and 8 months 1 day old, respectively 12, 14 and 14 weeks premature. In these experiments the sensitive period for knowing oneself as the sound-producer was thus 3-6 months of corrected age.

The experience of oneself as the sound-producer is presumably necessary to provide the blind infant with a frame of reference which will eventually enable him to understand that a sound made by another person or object may represent somebody or something reachable.

There is a great need for more investigations within this field.

Sequence-games

5.5.4 In the frame none of the infants played sequence-games, while in "The little Room" 11 infants played sequence-games with two objects, and 10 repeated such games.

Burlingham (1961), Fraiberg (1977) and Wills (1970) stated that auditory information is insufficient to allow the development of object concept.

Warren (1984) suggested that "audition-based object constancy for the six-month-old blind infant is not impossible if the object is an important enough one, and presumably if the infant has received prior information about the object via other modalities, such as touch".

These hypotheses are supported by the results of this study. In blind infants auditory development at a higher level than just listening, and integration of sense modalities in connection with objects of high preference, seemed to form the basis for understanding object concept and object permanence.

The simultaneous presence of several objects of high preference also encouraged the infants to perform comparisons. Maybe the sequence-games performed by 11 of the blind infants are a substitute for the visual comparisons which facilitate the sighted infant's learning of the existence of objects.

The many comparing activities played by the infants may imply that

1. A tactile experience is not perceived as a specific one without comparisons with another tactile quality, i.e. without a varied experience.

2. An object-based auditory performance is not perceived as a specific one unless there is knowledge of another object-based sound.

3. An object is not perceived as a specific one without the experience of another object.

Although immediate comparisons of tactile experiences and comparisons of self-produced object-based sounds are not a complete substitute for the sensory comparisons of a sighted infant it seems reasonable to suggest that tactile and auditory comparisons are of importance for the blind infant in achieving knowledge about the existence of objects. Without knowledge about the existence of objects the infant would not have been able to play sequence-games and would surely have been unable to repeat them. Repeating the same sequence-game in successive periods or after performing another acitivity indicates memory of both the specific objects used, and the position of them. As perception of an object is based on its kinesthetic, tactile and auditory properties this implies integration of sense modalities.

Bushnell (1981) stated that "intersensory development in infancy follows a range from performing knowledge to conscious intermodal knowledge". Even though this statement is outlined with considerations about visual-tactile integration in sighted infants, the present experiments suggest that the same range was shown by those blind infants who began to listen to the sounds while performing kinesthetic-tactile explorations.

Warren (1984) stated that "it seems reasonable to assume that the earlier the blind infant begins to receive *effective* correlated auditory and tactile experience, the better basis he would have for the development of adequate spatial relations concepts later".

Observations from the present study indicate that it is possible for blind infants to integrate sense modalities very early in life. Could it be that the sequence-games, the comparisons of activities and the comprehension of position of specific objects, presented by some of the blind infants were based on "conscious intermodal knowledge" or on "effective correlated auditory and tactile experience"?

Knowledge about integration of sense modalities in blind infants need considerably more attention.

Playing quantity games often enough to give a score was displayed by 3 infants only. The objects mostly used for quantity-games were the keys, the spoons and the small boxes. These objects were actually selected because they could be taken apart and for their auditory qualities, not for their use in quantity-games.

It was not expected that infants as young as 8 months 10 days, 11 months 7 days and 16 months 23 days (respectively 12, 11 and 8 weeks premature) could show interest in, and ability for, quantity-games. This ability should be taken into account in future investigations; perhaps more objects that can be "counted" would provoke the infant to further acitivities and explorations.

Positional Acitivities

5.5.5 Both Fraiberg (1977) and Wills (1970) consider the ability of reaching on the cue of sund as the milestone for exploration of the external world.

The result from the present study shows that motor milestones also form the basis for the blind infants' ability to explore their surroundings. If the congenitally blind infant does not suffer from motor disabilities, for example from cerebral palsy, and if sources of tactile and auditory properties are sufficiently available, he will show improvement from tactile or auditory feedback from his movements and perform more and more spatially related activities. Such experience initiates a process of comprehension of spatial relations between his own body and the objects placed around him, as well as between these objects.

In the frame, only one of the infants showed control of her surroundings. In "The little Room" 10 infants began to do so by

sweeping their hands through the air and 11 performed tactile control of position of objects.

During periods in the frame none of the infants showed an understanding of the position of any specific object. In "The little Room" 9 infants learnt about the precise position of several of the objects. This improvement was undoubtedly due to improvement in other areas. Understanding of the position of objects seemed to be learnt in parallel with improvement in the understanding of object concept and permanence.

The relative stability of the equipment in "The little Room" was presumably of importance for the infant in his growing understanding of where objects were in relation to himself. When an infant had taken an object from the magnet, he would drop it and then reach precisely in the direction from where the object had just been taken, he would then react with a disappointed or confused facial expression because the object was no longer there.

A stable reliable environment is necessary to give the infant a free choice in choosing a specific object, or a chance to play a specific game at a specific moment, and to perform comparisons of acitivities.

Repetitive Performance

5.5.6

In the frame four of the infants repeated the same activity immediately while 19 infants did so in "The little Room".

"The little Room" and its equipment gave opportunities for immediate repetition of the same activity. Such opportunity is usually unattainable in traditional environment, where the blind infant is unable to regain an object which has been dropped as quickly as he seems to need. Even if another peron replaces the object too many seconds have passed compared with the one to two seconds the infants in the study spent between each repetition. Repetitive actions could occur only because the object with which the activity was performed was still to be found in the same position.

It is reasonable to assume that this property of "The little Room" was important in establishing pre-understanding of spatial relations.

Primitive and More Conceptual Performance of Spatially Related Activities in "The little Room"

5.6 Table 12 deals with the performance of spatially related activities in "The little Room". Pre-kinesthetic, tactile and auditory skills are compared with the ability to play sequence-games and comprehension of position of objects.

The activities within the pre-kinesthetic, tactile and auditory fields are divided into primitive and more conceptual performance.

The pre-kinesthetic activities are subdivided in section B.

B1-2 represents the reflex-like grasping seen in very young infants, which is considered to be primitive.

B3-9 represents more consciously performed movement, such as moving an object from hand to hand.

Tactile activities are subdivided in section C.

C1-2 represents pre-understanding of tactile experience and C3-7 the more conceptually tactile performances.

Section D covers the auditory activities.

D1-3 is pre-understanding and D 4-6 comprehension of self as the producer of object-based sounds.

Subdivisions E1-3 represent sequence-games and F3-4, comprehension of the position of objects.

Presence of Kinesthetic. Tactile and Auditory Skills compared with Ability to Play Sequence-games and Comprehension of Position of Objects

Table 12

The skills are rated as present or absent. Scores are ignored. Numbers refer to number of infants.

Infants scoring	*Sequence-games (E1-3)*		*Comprehension of position of objects (F3-4)*	
	present	*absent*	*present*	*absent*
B1-2 but not B3-9	0	2	0	2
B3-9 but not C3-7	1	1	1	1
B3-9 but not D4-6	1	5	0	6
C1-2 but not C3-7	1	2	1	2
C3-7 but not B3-9	1	1	0	2
C3-7 but not D4-6	2	5	0	7
D1-3 but not D4-6	2	7	0	9
D4-6 but not C3-7	1	0	1	0
D4-6	10	1	10	1

The table shows that absence of comprehension of self-produced sounds is correlated with absence of the ability to play sequence-games and absence of comprehension of position of objects.

No other skills were of prognostic value.

Thus, primitive and more conceptual pre-kinesthetic and tactile abilities were insufficient to provide the infants with an appropriate base from which they could learn to play sequence-games, and comprehend the position of objects. Neither was the pre-understanding of oneself as producer of object-based sound sufficient. This study showed that the ability to understand oneself as the producer of object-based sounds was a prerequisite for beginning to play sequence-games and for comprehension of position of objects.

Two infants, however, played sequence-games without being given scores for comprehension of position of objects. Are sequence-games a stage which together with comprehension of self-produced sounds leads to comprehension of position of objects?

More investigations are necessary to answer this question, but a positive answer should influence the environments in which blind infants are placed.

More investigations are needed to determine whether understanding of oneself as the producer of object-based sound would facilitate understanding of other people as producers of object-based sounds. It should be investigated at which age the congenitally blind infant who has learned that he is the producer of object-based sounds will be able to reach on the cue of sound only, that is without such preceding tactile contact as the infants experienced in "The little Room".

It would also be interesting to know whether the blind infant as early in life as from the age of 3 months would benefit from a specific environment as "The little Room". And to know whether such early experience would enable congenitally blind infants to reach on a cue of sound before the age of 10 months mentioned by Fraiberg (1977) and others (Freedman, 1971; Wills, 1970). If this is so the optimal age for beginning of this experience should be investigated.

Comments on Stages of Improvement in Spatially Related Activities

5.7 The stages of improvement outlined in chapter 4.5 should be considered as a rough guide to the general developmental stages observed in the infants participating in this study. It should not be used to judge developmental levels of spatial relations in blind infants, but it could serve as a guideline to parents and other caregivers to observe improvements and to provide the blind infant with objects and surroundings which increase development of spatial relations.

Warburg (1982) stated that there is an obvious need for more refined methods of rating the development in these [blind mentally retarded] children".

Improvement in spatial relations is an important part of the development in blind infants and children. Observations for more than the 4-5 days described here are necessary to provide us with more knowledge about how congenitally blind infants can use their potential to get involved with their surroundings. The follow-

ing are suggestions for future investigations concerning movements, repetitive performance, tactile search, auditory experience, integration of sense modalities and estimation of position of objects and the distance between them.

Movements

We need more details concerning the pre-kinesthetic field, for example the various movements of hands, fingers and feet. The infants in this study actually used their feet to push the ceiling and walls of "The little Room", but it was impossible to interpret how or whether this behaviour was of importance for their understanding of spatial relations.

Also the movements of hands in different directions should be studied more thoroughly than they were in this study, during which most of the infants increased their range of hand and arm movements. "Look", a mother said, "she is moving her arm straight to the top of her head, that is what we are training her to do, because she never does it by herself". The fact that the infants got various tactile and auditory experience from their movements encouraged them to perform movements never done before. Perhaps different equipment in "The little Room" could bring about an even better result, in for example, midline organization of the hands.

When the problem of establishing midline organization of the hands has been solved this should be incorporated into the range of development and it should be investigated how such ability influences other stages of spatially related acitivities.

Repetitive performance.

More information is necessary on the infant's need for immediate repetition in interactions with adults, and whether this need disappears, decreases or continues when understanding of position of objects has become established.

Tactile search.

Within the field of tactile search we need details concerning integration of kinesthetic and tactile sense modalities; for example details of the particular patterns of movement necessary for tac-

tual exploration suggested by Jones (1975) (see chapter 1.5). Some of the infants in this study displayed a specific movement to search for the length of an object while they used another movement to search for small details of the object. It would also be interesting to know if specific stages of tactile search were associated with preference for specific tactile experience.

Auditory experience.

Little is known about the effect of high and low frequency sounds upon the awareness of blind infants, or how different frequencies influence the infant's play with object-based sounds.

Integration of sense modalities.

In this study some of the infants started with integration of kinesthetic and tactile sense modalities while others started with kinesthetic-auditory integration. Perhaps some congenitally blind infants are more sensitive to tactile stimulation from birth while others have audition as the primary sense, and perhaps some are born without any specific primary sense.

If blind infants are different from each other in this respect, the range of improvement in spatial relations may be outlined in two perhaps three different ways.

Judgement of position of objects and the distance between them.

The infants in this study became unexpectedly precise in their knowledge of the position of the objects they wanted to play with. The infants also enjoyed repeatingly touching objects from different directions as if to judge the distance between the objects.

Would this knowledge effect spatial activities in other environments or would certain conditions be necessary to enable the infants to transfer this knowledge from one environment to another.

More research is needed before a more detailed range of development can be described. This will improve the assessment of development in spatial relations and be of help in providing the blind infant with an environment which at any stage would give the best condition for further development.

Comments on Dependency on Training and Mediation

5.8

Adelson & Fraiberg (1974) have suggested that "blind infants after several months of experience with toys will find interest in the space immediately around them". Other authors (Cratty 1971; Drever, 1955; Hunter, 1964; Juurmaa, 1973) have suggested that the blind infant needs special training during a long period to become aware of his nearest surroundings.

The result from this study differs from these statements since most of the blind infants acquired spatial awareness sufficiently enough to explore their surrounding during as short a period as 4-5 days when they were placed in a specific environment.

Davidson & Nesker Simmons (1984) stated that "Development of involvement with the environment and active quering, self-directed exploring of it require early and continuous instruction and training by others – in short, sustained mediation. However, it is this sustained involvement by adults, necessary to provide the child with information, that is likely to foster in the young blind child a sense of dependency, of not being in command of interaction with the environment".

In the past we have perhaps focused too much on the blind infant's dependency on training and mediation of others instead of providing him with an environment where he can develop actively on his own.

If the blind infant experiences himself very early in life as the one who can explore independently and handle his environment, such experience may later promote his curiousity towards the wider world. Early independent activities might also encourage him to be an active participant in interaction with others and enable him to initiate such interactions.

Equilibrium between interaction with others and early independent exploration of the surroundings may induce the congenitally blind infant to function to the best of his abilities socially and independently in a world of both sighted and blind people.

Final Comments

5.9

Since it has been impossible to find any previous research on spatial relations in congenitally blind infants the result of the

present study is only related to the assumption of other authors. As mentioned in chapter 1.2 several authors suggest that the problems many blind children have with spatial relations are probably due to early lack of spatial experience. The theoretical review of the opportunity sighted and blind infants have to learn about the reality of the world (Chapter 1.1.) shows that traditional environments provide the blind infant with insufficient opportunity to achieve early spatial experience, while the result of this study shows that a specially designed environment facilitates the development of spatial relations in congenitally blind infants. Although further investigations are necessary to determine whether such early development will effect the ability to cope with spatial relations later on in life the result of this study indicates that very early experiences of spatial relations are of importance.

In most of the literature dealing with early development of blind infants, training and guidance are maintained as necessary. However, the result of this study shows that activities in a specially designed environment enables the congenitally blind infant to achieve early spatial relations through his own activities. The main effects of "The little Room" were the persevering activities resulting in comparisons of sensory experiences, integration of sense modalities, the learning of oneself as the producer of object-based sound, the comprehension of the position of a specific object and the opportunity to continue and to repeat an activity without interference from others.

To perceive oneself as a self-activated individual may in the mind of the blind infant be experienced as a contrast to interaction with others and thus form the idea that other persons are also able to act on their own. Likewise it is reasonable to suggest that early experiences of ones own activity establishes the habit of coping with explorations and difficulties by oneself and as such form the basis for later independency.

In the literature about blindness it is often mentioned which compensation system the blind infant needs. However, the congenitally blind individual will never experience himself as the one who needs a system to compensate for lack of sight. He has never had the experience to see and he will never be able to understand what this really means. While learning about spatial relations and the concept and permanence of objects the congenitally blind in-

fant will rely on quite different cues than the sighted infant but like the sighted infant he needs experiences of comparisons and sequence-games. However, such activities can only be performed if environments of sufficient quality are available for him. To be able to fulfil his need for such environments we have to learn what the nature of blindness means, that is, how the blind infant experiences his surrounding, how he establishes integration of sense-modalities, which materials motivate him for experiments and explorations, how he transfers skills from one environment to another and how he becomes a contributor in interaction with others. Without the understanding of the nature of blindness the congenitally blind infant and child may come to suffer from unnecessary delayed development.

From observation and reasearch we must learn how to facilitate the blind infants' opportunity in developing to the best of his potential. However, whatever we do we must always remember that it is natural for the blind individual to be blind.

Summary and Conclusion

Aim of Study.

Together with a theoretical description of the differences between sighted and blind infants' opportunity to achieve early understanding of their surroundings a review of early studies and observations introduce the present study of spatial relations in congenitally blind infants.

The aim of this study was to discover whether a specially designed experimental environment would facilitate the development of early spatial relations, and to observe which properties of this environment would improve the development of spatial relations very early in the life of the congenitally blind infant.

Description of Study.

Congenitally blind infants were exposed to the material "The little Room" which is a framework of pipes with attached panels. The frame without the panels was used as the control environment. Both the frame and "The little Room" were similarly equipped with several objects of different tactile and auditory qualities.

The subjects were 20 congenitally blind infants aged 5-19 months; eleven of them were blind only, 9 were also mentally retarded. They were divided into 4 groups of 5 infants. Each infant was video recorded according to one of 4, randomly selected descriptions of a varying number of periods in the frame and in "The little Room".

Every infant was recorded for 8 periods of 20 minutes duration. For each of the 20 infants all periods of video records took place within 4-5 days of one week.

The scoring system was devised from observation of the most common activities in a total of 54 hours of records.

Performance of spatially related activities was assessed in both the frame and "The little Room". The pre-kinesthetic, tactile and auditory fields were assessed, also the ability to play sequence-games and the comprehension of position of objects. Scores were also given for performance of immediate repetition of activities.

Findings

All the infants showed their capability in the frame within the first period of 20 minutes, no further improvement was observed during subsequent periods. Compared with their performance in the frame, 14 of the 15 infants who stayed in "The little Room" for 4, 6 and 8 periods of 20 minutes gradually improved in performing spatially related activities.

Playing sequence-games and understanding of the position of objects were only displayed in "The little Room".

Where the total scores for the infants as a group are concerned, the overall improvement was significant at $p. < 0{,}6\%$ (Kendall's test).

Improvement within the tactile field was almost the same for all the infants; four periods sufficed to achieve this, while 6 and 8 periods did not produce any further improvement of tactile performance.

Auditory activities improved as eleven infants learned that they were the producers of the emerging object-based sounds, and this knowledge enabled them to play sequence-games and to understand the position of objects.

The mentally retarded infants improved almost as much as those who were only blind, but they needed more time in "The little Room" to achieve this.

Male infants were not as capable as female infants in the frame but in "The little Room" male infants improved to the same level as female infants.

Infants younger than 10 months of age improved nearly as much as infants older than 10 months of age.

The infants clearly showed preference for objects of specific qualities such as those with a surface of acute points, and objects whose form could be changed or which could be taken apart.

Stability of the experimental environment was necessary to introduce object concept and understanding of the position of objects which happened as a correlation of tactile and auditory experience.

Analysis & Discussion of Findings.

The results from the study show that congenitally blind infants are able to establish spatially related knowledge very early in life when given a specific environment. This understanding of spatial relations seems to occur as a developmental process, which starts by consciousness of tactile and auditory feedback on pre-kinesthetic movements. Pre-kinesthetic capability was necessary for improvement in the tactile and auditory fields. Improvement in the field of sequence-games and in comprehension of position of objects depended on the integration of sense-modalities.

The progress which took place in "The little Room" seems to be due to many factors: elimination of sounds from the outside world, echoes inside "The little Room", the presence of several objects of preference, the possibility to repeat an activity immediately, the possibility to compare sensory experiences, the stability of "The little Room" and the absence of interference. All these factors led to a growing integration of the sense modalities and enabled the infant to discover that he could produce his own object-based sounds. Midline organization of the hands did not improve in "The little Room". However, observations of the unsuccessful attempts of some of the infants to use both hands at the same time could indicate that different equipment might facilitate this development.

Recommendations and Conclusion

The hypothesis that a specially designed environment would facilitate the development of early spatial relations in congenitally blind infants was supported by the results from this study.

These results support the hypothesis of others that spatial distinctions are founded upon voluntary movements (Jones, 1975), that awareness of external objects depends on adequate feedback from preliminary movements (Tobin, 1980) and that audition-based constancy for the six-month-old blind infant is not impossible (Warren, 1984).

The findings indicate that blindness is no impediment to the development of early spatial relations, as long as the blind infant is given an environment that enables him to achieve pre-understanding of object concept and permanence and knowledge about himself as the producer of object-based sounds. However, observations over a much longer period are necessary, to determine whether the promotion in spatial relations which occurred during one week would enable the infant to transfer the learned ability to reach for objects, to reaching on the cue of object-based sounds made by other people.

Other observations from the study gave rise to suggestions for future investigations, for example how the various movements of hands, fingers and feet influence the development of spatial relations – whether the presented need for immediate repetition of an activity would disappear, decrease or continue – which properties of objects would produce maximal attention – how further integration of sense modalities could occur – whether knowledge of oneself as the sound-producer would enable the blind infant to reach on the cue of sound earlier in life than the age of 10 months mentioned by Fraiberg (1977) and whether certain conditions are necessary to enable the infant to transfer gained understanding of spatial relations from one environment to another.

The fact that the improvement occurred within 4-5 days opposes the view that several months of experience and training is necessary for the blind infant to become aware of his nearest surroundings (Adelson & Fraiberg, 1974; Cratty, 1971; Drever, 1955; Hunter, 1964; Juurmaa, 1973). The results also oppose the statement from Davidson & Nesker Simmons (1984), that development of involvement with the environment requires early instruction and training by others. In fact the findings suggest that

equilibrium between interaction with others and activities on his own would enable the congenitally blind infant to achieve a frame of reference about spatial relations, which would mean that he would be less passive on his own as well as in his interaction with others.

On the basis of this study I believe that congenitally blind infants as early as 3 months of age should be given the opportunity to become familiar with a special environment such as "The little Room", so that they can begin to exercise spatially related activities as early in life as possible. However, more investigations are needed to determine whether periods of time in a specifically organised environment would provide the blind infant with a frame of reference about space which he can use in the outside world.

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Appendix

Group 6/2: Case no. 1. Boy, 11 mo. 25 d. Impairments: Hydroplasia of the optic nerves, epilepsy, mental retardation, congenital malformation of the brain (Dandy Walker).

	The Frame	*The little Room*
A 1: mouthing own hand	+	—
A 2: hand(s) contacting eye(s)	—	—
A 3: playing own fingers	+	—
B 1: grasp and let go object	—	+
B 2: grasp and keep object	—	+
B 3: mouthing object	—	—
B 4: move object from hand to hand	—	—
B 5: turn object using hands	—	—
B 6: tap object on own body	—	—
B 7: tap object on wall/platform	—	—
B 8: pick up object	—	—
B 9: pick up object just dropped	—	—
C 1: detect of tactile contact of objects	—	+
C 2: recall tactile contact of objects	—	—
C 3: touch walls/ceiling	—	+
C 4: tactile search for dropped object	—	—
C 5: tactile search of details of object	—	+
C 6: tactile search of structure of walls	—	—
C 7: compare tactile experience	—	+
D 1: react to self-produced sound	—	+
D 2: push objects making sound	—	+
D 3: rattle to produce sound	—	—
D 4: grasp just after self-produced sound	—	+
D 5: comprehend self-produced sound	—	+
D 6: compare self-produced sounds	—	—
E 1: play sequence-game with 2 objects	—	—
E 2: play sequence-game, several objects	—	—
E 3: repeat sequence-game	—	—
E 4: quantity-games	—	—
E 5: comparing games	—	—
F 1: control by circular sweep of hand	—	—
F 2: tactile control of position of object	—	+
F 3: comprehend position of specific object	—	—
F 4: compare positions of objects	—	—
G 1: repeat the same activity immediately	—	+
G 2: interrupt activity for few seconds	—	—
Total B-F	0	11

Table 14

Group 6/2: Case no. 2. Girl, 12 mo. 23 d. Impairment: Optic atrophy.

	The Frame	*The little Room*
A 1: mouthing own hand	+	+
A 2: hand(s) contacting eye(s)	—	—
A 3: playing own fingers	+	+
B 1: grasp and let go object	+	+
B 2: grasp and keep object	+	+
B 3: mouthing object	+	+
B 4: move object from hand to hand	+	+
B 5: turn object using hands	+	+
B 6: tap object on own body	—	—
B 7: tap object on wall/platform	—	—
B 8: pick up object	—	—
B 9: pick up object just dropped	—	—
C 1: detect of tactile contact of objects	+	+
C 2: recall tactile contact of objects	—	—
C 3: touch walls/ceiling	—	—
C 4: tactile search for dropped object	—	—
C 5: tactile search of details of object	—	—
C 6: tactile search of structure of walls	—	—
C 7: compare tactile experience	—	—
D 1: react to self-produced sound	+	+
D 2: push objects making sound	—	+
D 3: rattle to produce sound	—	—
D 4: grasp just after self-produced sound	—	—
D 5: comprehend self-produced sound	—	—
D 6: compare self-produced sounds	—	—
E 1: play sequence-game with 2 objects	—	—
E 2: play sequence-game, several objects	—	—
E 3: repeat sequence-game	—	—
E 4: quantity-games	—	—
E 5: comparing games	—	—
F 1: control by circular sweep of hand	—	—
F 2: tactile control of position of object	—	—
F 3: comprehend position of specific object	—	—
F 4: compare positions of objects	—	—
G 1: repeat the same activity immediately	—	+
G 2: interrupt activity for few seconds	—	—
Total B-F	7	8

Group 6/2: Case no. 3. Boy, 14 mo. 8 d. Impairments: Hydrocephalus, mental retardation.

	The Frame	*The little Room*
A 1: mouthing own hand	+	+
A 2: hand(s) contacting eye(s)	—	—
A 3: playing own fingers	+	—
B 1: grasp and let go object	+	+
B 2: grasp and keep object	—	—
B 3: mouthing object	—	—
B 4: move object from hand to hand	—	—
B 5: turn object using hands	—	—
B 6: tap object on own body	—	—
B 7: tap object on wall/platform	—	—
B 8: pick up object	—	—
B 9: pick up object just dropped	—	—
C 1: detect of tactile contact of objects	+	+
C 2: recall tactile contact of objects	—	—
C 3: touch walls/ceiling	—	+
C 4: tactile search for dropped object	—	—
C 5: tactile search of details of object	—	—
C 6: tactile search of structure of walls	—	—
C 7: compare tactile experience	—	—
D 1: react to self-produced sound	+	+
D 2: push objects making sound	—	—
D 3: rattle to produce sound	—	—
D 4: grasp just after self-produced sound	—	—
D 5: comprehend self-produced sound	—	—
D 6: compare self-produced sounds	—	—
E 1: play sequence-game with 2 objects	—	—
E 2: play sequence-game, several objects	—	—
E 3: repeat sequence-game	—	—
E 4: quantity-games	—	—
E 5: comparing games	—	—
F 1: control by circular sweep of hand	—	—
F 2: tactile control of position of object	—	—
F 3: comprehend position of specific object	—	—
F 4: compare positions of objects	—	—
G 1: repeat the same activity immediately	—	+
G 2: interrupt activity for few seconds	—	—
Total B-F	3	4

Table 16

Group 6/2: Case no. 4. Boy, 7 mo. 29 d. Impairments: Congenital amaurosis, hydrocephalus, mental retardation.

	The Frame	*The little Room*
A 1: mouthing own hand	+	+
A 2: hand(s) contacting eye(s)	—	—
A 3: playing own fingers	—	—
B 1: grasp and let go object	—	—
B 2: grasp and keep object	—	—
B 3: mouthing object	—	—
B 4: move object from hand to hand	—	—
B 5: turn object using hands	—	—
B 6: tap object on own body	—	—
B 7: tap object on wall/platform	—	—
B 8: pick up object	—	—
B 9: pick up object just dropped	—	—
C 1: detect of tactile contact of objects	+	+
C 2: recall tactile contact of objects	—	—
C 3: touch walls/ceiling	—	—
C 4: tactile search for dropped object	—	—
C 5: tactile search of details of object	—	—
C 6: tactile search of structure of walls	—	—
C 7: compare tactile experience	—	—
D 1: react to self-produced sound	+	+
D 2: push objects making sound	—	—
D 3: rattle to produce sound	—	—
D 4: grasp just after self-produced sound	—	—
D 5: comprehend self-produced sound	—	—
D 6: compare self-produced sounds	—	—
E 1: play sequence-game with 2 objects	—	—
E 2: play sequence-game, several objects	—	—
E 3: repeat sequence-game	—	—
E 4: quantity-games	—	—
E 5: comparing games	—	—
F 1: control by circular sweep of hand	—	—
F 2: tactile control of position of object	—	—
F 3: comprehend position of specific object	—	—
F 4: compare positions of objects	—	—
G 1: repeat the same activity immediately	—	—
G 2: interrupt activity for few seconds	—	—
Total B-F	2	2

Group 6/2: Case no. 5. Girl, 11 mo. 4 d. Impairment: Leber's congenital amaurosis.

	The Frame	*The little Room*
A 1: mouthing own hand	—	—
A 2: hand(s) contacting eye(s)	+	+
A 3: playing own fingers	—	—
B 1: grasp and let go object	+	+
B 2: grasp and keep object	+	+
B 3: mouthing object	+	+
B 4: move object from hand to hand	+	+
B 5: turn object using hands	+	+
B 6: tap object on own body	—	—
B 7: tap object on wall/platform	—	+
B 8: pick up object	+	+
B 9: pick up object just dropped	+	+
C 1: detect of tactile contact of objects	+	+
C 2: recall tactile contact of objects	+	+
C 3: touch walls/ceiling	—	+
C 4: tactile search for dropped object	—	—
C 5: tactile search of details of object	+	+
C 6: tactile search of structure of walls	—	+
C 7: compare tactile experience	+	+
D 1: react to self-produced sound	+	+
D 2: push objects making sound	—	—
D 3: rattle to produce sound	—	+
D 4: grasp just after self-produced sound	—	—
D 5: comprehend self-produced sound	—	—
D 6: compare self-produced sounds	—	—
E 1: play sequence-game with 2 objects	—	+
E 2: play sequence-game, several objects	—	—
E 3: repeat sequence-game	—	+
E 4: quantity-games	—	—
E 5: comparing games	+	+
F 1: control by circular sweep of hand	—	—
F 2: tactile control of position of object	—	—
F 3: comprehend position of specific object	—	—
F 4: compare positions of objects	—	—
G 1: repeat the same activity immediately	+	+
G 2: interrupt activity for few seconds	—	—
Total B-F	13	19

Table 18

Group 4/4: Case no. 6. Boy, 12 mo. 22 d. Impairments: Cortical amaurosis, cerebral palsy, epilepsy, mental retardation.

	The Frame	*The little Room*
A 1: mouthing own hand	—	—
A 2: hand(s) contacting eye(s)	—	—
A 3: playing own fingers	—	—
B 1: grasp and let go object	—	—
B 2: grasp and keep object	—	—
B 3: mouthing object	—	+
B 4: move object from hand to hand	—	—
B 5: turn object using hands	—	—
B 6: tap object on own body	—	—
B 7: tap object on wall/platform	—	—
B 8: pick up object	—	—
B 9: pick up object just dropped	—	—
C 1: detect of tactile contact of objects	—	+
C 2: recall tactile contact of objects	—	—
C 3: touch walls/ceiling	—	+
C 4: tactile search for dropped object	—	—
C 5: tactile search of details of object	—	—
C 6: tactile search of structure of walls	—	—
C 7: compare tactile experience	—	—
D 1: react to self-produced sound	—	+
D 2: push objects making sound	—	+
D 3: rattle to produce sound	—	—
D 4: grasp just after self-produced sound	—	—
D 5: comprehend self-produced sound	—	—
D 6: compare self-produced sounds	—	—
E 1: play sequence-game with 2 objects	—	—
E 2: play sequence-game, several objects	—	—
E 3: repeat sequence-game	—	—
E 4: quantity-games	—	—
E 5: comparing games	—	—
F 1: control by circular sweep of hand	—	—
F 2: tactile control of position of object	—	—
F 3: comprehend position of specific object	—	—
F 4: compare positions of objects	—	—
G 1: repeat the same activity immediately	—	+
G 2: interrupt activity for few seconds	—	—
Total B-F	0	5

Group 4/4: Case no. 7. Boy, 13 mo. 3 d. Impairment: Congenital amaurosis. Prematurity: 14 weeks.

	The Frame	*The little Room*
A 1: mouthing own hand	+	—
A 2: hand(s) contacting eye(s)	+	—
A 3: playing own fingers	—	—
B 1: grasp and let go object	+	+
B 2: grasp and keep object	—	+
B 3: mouthing object	+	+
B 4: move object from hand to hand	+	+
B 5: turn object using hands	—	+
B 6: tap object on own body	+	—
B 7: tap object on wall/platform	—	+
B 8: pick up object	+	+
B 9: pick up object just dropped	—	+
C 1: detect of tactile contact of objects	+	+
C 2: recall tactile contact of objects	—	+
C 3: touch walls/ceiling	—	+
C 4: tactile search for dropped object	—	+
C 5: tactile search of details of object	—	+
C 6: tactile search of structure of walls	—	+
C 7: compare tactile experience	—	+
D 1: react to self-produced sound	+	+
D 2: push objects making sound	—	+
D 3: rattle to produce sound	+	+
D 4: grasp just after self-produced sound	—	+
D 5: comprehend self-produced sound	—	+
D 6: compare self-produced sounds	—	+
E 1: play sequence-game with 2 objects	—	+
E 2: play sequence-game, several objects	—	+
E 3: repeat sequence-game	—	—
E 4: quantity-games	—	—
E 5: comparing games	—	—
F 1: control by circular sweep of hand	—	+
F 2: tactile control of position of object	—	+
F 3: comprehend position of specific object	—	+
F 4: compare positions of objects	—	+
G 1: repeat the same activity immediately	—	+
G 2: interrupt activity for few seconds	—	+
Total B-F	8	27

Table 20

Group 4/4: Case no. 8. Boy, 9 mo. 0 d. Impairment: Retinopathy of prematurity. Prematurity: 10 weeks.

	The Frame	*The little Room*
A 1: mouthing own hand	+	+
A 2: hand(s) contacting eye(s)	—	—
A 3: playing own fingers	—	—
B 1: grasp and let go object	+	+
B 2: grasp and keep object	+	+
B 3: mouthing object	+	+
B 4: move object from hand to hand	—	—
B 5: turn object using hands	—	—
B 6: tap object on own body	—	—
B 7: tap object on wall/platform	—	—
B 8: pick up object	+	+
B 9: pick up object just dropped	+	+
C 1: detect of tactile contact of objects	+	+
C 2: recall tactile contact of objects	—	—
C 3: touch walls/ceiling	—	+
C 4: tactile search for dropped object	—	—
C 5: tactile search of details of object	—	—
C 6: tactile search of structure of walls	—	—
C 7: compare tactile experience	—	+
D 1: react to self-produced sound	—	+
D 2: push objects making sound	—	—
D 3: rattle to produce sound	—	+
D 4: grasp just after self-produced sound	—	—
D 5: comprehend self-produced sound	—	—
D 6: compare self-produced sounds	—	—
E 1: play sequence-game with 2 objects	—	—
E 2: play sequence-game, several objects	—	—
E 3: repeat sequence-game	—	—
E 4: quantity-games	—	—
E 5: comparing games	—	—
F 1: control by circular sweep of hand	—	—
F 2: tactile control of position of object	—	—
F 3: comprehend position of specific object	—	—
F 4: compare positions of objects	—	—
G 1: repeat the same activity immediately	—	+
G 2: interrupt activity for few seconds	—	—
Total B-F	6	10

Group 4/4: Case no. 9. Boy, 6 mo. 3 d. Impairment: Retinopathy of prematurity. Prematurity: 12 weeks.

	The Frame	*The little Room*
A 1: mouthing own hand	—	—
A 2: hand(s) contacting eye(s)	—	—
A 3: playing own fingers	—	—
B 1: grasp and let go object	—	+
B 2: grasp and keep object	—	+
B 3: mouthing object	—	+
B 4: move object from hand to hand	—	—
B 5: turn object using hands	—	—
B 6: tap object on own body	—	—
B 7: tap object on wall/platform	—	—
B 8: pick up object	—	—
B 9: pick up object just dropped	—	—
C 1: detect of tactile contact of objects	+	+
C 2: recall tactile contact of objects	—	+
C 3: touch walls/ceiling	—	+
C 4: tactile search for dropped object	—	—
C 5: tactile search of details of object	—	+
C 6: tactile search of structure of walls	—	—
C 7: compare tactile experience	—	+
D 1: react to self-produced sound	—	+
D 2: push objects making sound	—	+
D 3: rattle to produce sound	—	+
D 4: grasp just after self-produced sound	—	+
D 5: comprehend self-produced sound	—	+
D 6: compare self-produced sounds	—	+
E 1: play sequence-game with 2 objects	—	+
E 2: play sequence-game, several objects	—	—
E 3: repeat sequence-game	—	+
E 4: quantity-games	—	—
E 5: comparing games	—	+
F 1: control by circular sweep of hand	—	—
F 2: tactile control of position of object	—	+
F 3: comprehend position of specific object	—	+
F 4: compare positions of objects	—	—
G 1: repeat the same activity immediately	—	+
G 2: interrupt activity for few seconds	—	+
Total B-F	1	19

Table 22

Group 4/4: Case no. 10. Boy, 14 mo. 20 d. Impairments: Cortical amaurosis, epilepsy, cerebral palsy, mental retardation.

	The Frame	*The little Room*
A 1: mouthing own hand	+	+
A 2: hand(s) contacting eye(s)	+	+
A 3: playing own fingers	—	—
B 1: grasp and let go object	—	—
B 2: grasp and keep object	—	—
B 3: mouthing object	—	—
B 4: move object from hand to hand	—	—
B 5: turn object using hands	—	—
B 6: tap object on own body	—	—
B 7: tap object on wall/platform	—	—
B 8: pick up object	—	—
B 9: pick up object just dropped	—	—
C 1: detect of tactile contact of objects	+	+
C 2: recall tactile contact of objects	—	+
C 3: touch walls/ceiling	—	+
C 4: tactile search for dropped object	—	—
C 5: tactile search of details of object	—	—
C 6: tactile search of structure of walls	—	—
C 7: compare tactile experience	—	—
D 1: react to self-produced sound	+	+
D 2: push objects making sound	+	+
D 3: rattle to produce sound	—	—
D 4: grasp just after self-produced sound	—	—
D 5: comprehend self-produced sound	—	—
D 6: compare self-produced sounds	—	—
E 1: play sequence-game with 2 objects	—	+
E 2: play sequence-game, several objects	—	—
E 3: repeat sequence-game	—	+
E 4: quantity-games	—	—
E 5: comparing games	—	—
F 1: control by circular sweep of hand	—	—
F 2: tactile control of position of object	—	+
F 3: comprehend position of specific object	—	—
F 4: compare positions of objects	—	—
G 1: repeat the same activity immediately	—	+
G 2: interrupt activity for few seconds	—	—
Total B-F	3	8

Group 2/6: Case no. 11. Girl, 11 mo. 7 d. Impairment: Retinopathy of prematurity. Prematurity: 11 weeks.

	The Frame	*The little Room*
A 1: mouthing own hand	—	—
A 2: hand(s) contacting eye(s)	+	+
A 3: playing own fingers	—	—
B 1: grasp and let go object	+	+
B 2: grasp and keep object	+	+
B 3: mouthing object	+	+
B 4: move object from hand to hand	+	+
B 5: turn object using hands	+	+
B 6: tap object on own body	—	+
B 7: tap object on wall/platform	—	+
B 8: pick up object	+	+
B 9: pick up object just dropped	—	—
C 1: detect of tactile contact of objects	+	+
C 2: recall tactile contact of objects	+	+
C 3: touch walls/ceiling	—	+
C 4: tactile search for dropped object	—	—
C 5: tactile search of details of object	+	+
C 6: tactile search of structure of walls	—	+
C 7: compare tactile experience	+	+
D 1: react to self-produced sound	—	+
D 2: push objects making sound	—	+
D 3: rattle to produce sound	—	—
D 4: grasp just after self-produced sound	—	+
D 5: comprehend self-produced sound	—	+
D 6: compare self-produced sounds	—	—
E 1: play sequence-game with 2 objects	—	+
E 2: play sequence-game, several objects	—	+
E 3: repeat sequence-game	—	+
E 4: quantity-games	—	+
E 5: comparing games	—	+
F 1: control by circular sweep of hand	+	+
F 2: tactile control of position of object	+	+
F 3: comprehend position of specific object	—	+
F 4: compare positions of objects	—	+
G 1: repeat the same activity immediately	+	+
G 2: interrupt activity for few seconds	—	+
Total B-F	12	27

Table 24

Group 2/6: Case no. 12. Girl, 5 mo. 14 d. Impairments: Bilateral anophthalmos, porensephaly.

	The Frame	*The little Room*
A 1: mouthing own hand	+	+
A 2: hand(s) contacting eye(s)	—	—
A 3: playing own fingers	+	+
B 1: grasp and let go object	+	+
B 2: grasp and keep object	+	+
B 3: mouthing object	+	+
B 4: move object from hand to hand	+	+
B 5: turn object using hands	—	—
B 6: tap object on own body	—	—
B 7: tap object on wall/platform	—	—
B 8: pick up object	—	—
B 9: pick up object just dropped	—	—
C 1: detect of tactile contact of objects	+	+
C 2: recall tactile contact of objects	—	+
C 3: touch walls/ceiling	—	+
C 4: tactile search for dropped object	—	—
C 5: tactile search of details of object	—	—
C 6: tactile search of structure of walls	—	—
C 7: compare tactile experience	—	—
D 1: react to self-produced sound	—	+
D 2: push objects making sound	—	+
D 3: rattle to produce sound	—	—
D 4: grasp just after self-produced sound	—	—
D 5: comprehend self-produced sound	—	—
D 6: compare self-produced sounds	—	—
E 1: play sequence-game with 2 objects	—	—
E 2: play sequence-game, several objects	—	—
E 3: repeat sequence-game	—	—
E 4: quantity-games	—	—
E 5: comparing games	—	—
F 1: control by circular sweep of hand	—	+
F 2: tactile control of position of object	—	+
F 3: comprehend position of specific object	—	—
F 4: compare positions of objects	—	—
G 1: repeat the same activity immediately	—	+
G 2: interrupt activity for few seconds	—	+
Total B-F	5	11

Group 2/6: Case no. 13. Boy, 9 mo. 3 d. Impairment: Retinopathy of prematurity. Prematurity: 14 weeks.

	The Frame	*The little Room*
A 1: mouthing own hand	+	—
A 2: hand(s) contacting eye(s)	—	—
A 3: playing own fingers	+	—
B 1: grasp and let go object	+	+
B 2: grasp and keep object	+	+
B 3: mouthing object	+	+
B 4: move object from hand to hand	—	—
B 5: turn object using hands	—	—
B 6: tap object on own body	—	—
B 7: tap object on wall/platform	+	+
B 8: pick up object	—	—
B 9: pick up object just dropped	—	—
C 1: detect of tactile contact of objects	+	+
C 2: recall tactile contact of objects	—	+
C 3: touch walls/ceiling	—	+
C 4: tactile search for dropped object	—	—
C 5: tactile search of details of object	—	—
C 6: tactile search of structure of walls	—	—
C 7: compare tactile experience	—	+
D 1: react to self-produced sound	+	+
D 2: push objects making sound	+	+
D 3: rattle to produce sound	+	+
D 4: grasp just after self-produced sound	—	+
D 5: comprehend self-produced sound	—	+
D 6: compare self-produced sounds	—	+
E 1: play sequence-game with 2 objects	—	+
E 2: play sequence-game, several objects	—	+
E 3: repeat sequence-game	—	+
E 4: quantity-games	—	—
E 5: comparing games	—	+
F 1: control by circular sweep of hand	—	+
F 2: tactile control of position of object	—	+
F 3: comprehend position of specific object	—	+
F 4: compare positions of objects	—	—
G 1: repeat the same activity immediately	—	+
G 2: interrupt activity for few seconds	—	+
Total B-F	8	21

Table 26

Group 2/6: Case no. 14. Girl, 8 mo. 20 d. Impairment: Cortical amaurosis.

	The Frame	*The little Room*
A 1: mouthing own hand	—	—
A 2: hand(s) contacting eye(s)	—	—
A 3: playing own fingers	—	—
B 1: grasp and let go object	+	+
B 2: grasp and keep object	+	+
B 3: mouthing object	+	+
B 4: move object from hand to hand	+	+
B 5: turn object using hands	+	+
B 6: tap object on own body	+	+
B 7: tap object on wall/platform	+	+
B 8: pick up object	—	—
B 9: pick up object just dropped	—	—
C 1: detect of tactile contact of objects	+	+
C 2: recall tactile contact of objects	—	+
C 3: touch walls/ceiling	—	+
C 4: tactile search for dropped object	—	—
C 5: tactile search of details of object	—	+
C 6: tactile search of structure of walls	—	—
C 7: compare tactile experience	—	+
D 1: react to self-produced sound	+	+
D 2: push objects making sound	+	+
D 3: rattle to produce sound	+	+
D 4: grasp just after self-produced sound	—	+
D 5: comprehend self-produced sound	—	+
D 6: compare self-produced sounds	—	+
E 1: play sequence-game with 2 objects	—	+
E 2: play sequence-game, several objects	—	—
E 3: repeat sequence-game	—	—
E 4: quantity-games	—	—
E 5: comparing games	—	+
F 1: control by circular sweep of hand	—	+
F 2: tactile control of position of object	—	+
F 3: comprehend position of specific object	—	—
F 4: compare positions of objects	—	+
G 1: repeat the same activity immediately	+	+
G 2: interrupt activity for few seconds	+	+
Total B-F	11	23

Group 2/6: Case no. 15. Boy, 12 mo. 24 d. Impairments: Optic atrophy, neonatal asphyxia, mental retardation.

	The Frame	*The little Room*
A 1: mouthing own hand	—	—
A 2: hand(s) contacting eye(s)	—	—
A 3: playing own fingers	+	—
B 1: grasp and let go object	+	+
B 2: grasp and keep object	+	+
B 3: mouthing object	—	+
B 4: move object from hand to hand	—	—
B 5: turn object using hands	—	—
B 6: tap object on own body	—	+
B 7: tap object on wall/platform	—	+
B 8: pick up object	—	—
B 9: pick up object just dropped	—	—
C 1: detect of tactile contact of objects	—	+
C 2: recall tactile contact of objects	—	+
C 3: touch walls/ceiling	—	+
C 4: tactile search for dropped object	—	—
C 5: tactile search of details of object	—	—
C 6: tactile search of structure of walls	—	—
C 7: compare tactile experience	—	—
D 1: react to self-produced sound	+	+
D 2: push objects making sound	+	+
D 3: rattle to produce sound	—	+
D 4: grasp just after self-produced sound	—	+
D 5: comprehend self-produced sound	—	+
D 6: compare self-produced sounds	—	+
E 1: play sequence-game with 2 objects	—	—
E 2: play sequence-game, several objects	—	+
E 3: repeat sequence-game	—	+
E 4: quantity-games	—	—
E 5: comparing games	—	—
F 1: control by circular sweep of hand	—	+
F 2: tactile control of position of object	—	—
F 3: comprehend position of specific object	—	+
F 4: compare positions of objects	—	—
G 1: repeat the same activity immediately	+	+
G 2: interrupt activity for few seconds	+	+
Total B-F	4	18

Table 28

Group ½/8: Case no. 16. Boy, 8 mo. 10 d. Impairment: Retinopathy of prematurity. Prematurity: 12 weeks.

	The Frame	*The little Room*
A 1: mouthing own hand	—	—
A 2: hand(s) contacting eye(s)	—	—
A 3: playing own fingers	—	—
B 1: grasp and let go object	+	+
B 2: grasp and keep object	+	+
B 3: mouthing object	—	+
B 4: move object from hand to hand	—	+
B 5: turn object using hands	—	+
B 6: tap object on own body	—	—
B 7: tap object on wall/platform	—	—
B 8: pick up object	—	—
B 9: pick up object just dropped	—	—
C 1: detect of tactile contact of objects	+	+
C 2: recall tactile contact of objects	—	+
C 3: touch walls/ceiling	—	+
C 4: tactile search for dropped object	—	—
C 5: tactile search of details of object	—	+
C 6: tactile search of structure of walls	—	—
C 7: compare tactile experience	—	+
D 1: react to self-produced sound	—	+
D 2: push objects making sound	—	+
D 3: rattle to produce sound	—	—
D 4: grasp just after self-produced sound	—	—
D 5: comprehend self-produced sound	—	—
D 6: compare self-produced sounds	—	—
E 1: play sequence-game with 2 objects	—	—
E 2: play sequence-game, several objects	—	—
E 3: repeat sequence-game	—	—
E 4: quantity-games	—	+
E 5: comparing games	—	—
F 1: control by circular sweep of hand	—	—
F 2: tactile control of position of object	—	—
F 3: comprehend position of specific object	—	—
F 4: compare positions of objects	—	—
G 1: repeat the same activity immediately	—	+
G 2: interrupt activity for few seconds	—	+
Total B-F	3	13

Group ½/8: Case no. 17. Boy, 16 mo. 23 d. Impairments: Retinopathy of prematurity, mental retardation. Prematurity: 8 weeks.

	The Frame	*The little Room*
A 1: mouthing own hand	—	—
A 2: hand(s) contacting eye(s)	—	—
A 3: playing own fingers	—	—
B 1: grasp and let go object	+	+
B 2: grasp and keep object	+	+
B 3: mouthing object	—	—
B 4: move object from hand to hand	+	+
B 5: turn object using hands	—	+
B 6: tap object on own body	—	+
B 7: tap object on wall/platform	—	—
B 8: pick up object	+	+
B 9: pick up object just dropped	—	+
C 1: detect of tactile contact of objects	+	+
C 2: recall tactile contact of objects	+	+
C 3: touch walls/ceiling	—	+
C 4: tactile search for dropped object	—	+
C 5: tactile search of details of object	+	+
C 6: tactile search of structure of walls	—	—
C 7: compare tactile experience	—	+
D 1: react to self-produced sound	—	+
D 2: push objects making sound	—	+
D 3: rattle to produce sound	—	+
D 4: grasp just after self-produced sound	—	+
D 5: comprehend self-produced sound	—	+
D 6: compare self-produced sounds	—	+
E 1: play sequence-game with 2 objects	—	+
E 2: play sequence-game, several objects	—	—
E 3: repeat sequence-game	—	+
E 4: quantity-games	—	+
E 5: comparing games	—	+
F 1: control by circular sweep of hand	—	+
F 2: tactile control of position of object	—	+
F 3: comprehend position of specific object	—	+
F 4: compare positions of objects	—	+
G 1: repeat the same activity immediately	—	+
G 2: interrupt activity for few seconds	—	+
Total B-F	7	27

Table 30

Group ½/8: Case no. 18. Girl, 15 mo. 11 d. Impairments: Retinopathy of prematurity, cerebral palsy, hydrocephalus, mental retardation. Prematurity: 12 weeks.

	The Frame	*The little Room*
A 1: mouthing own hand	—	—
A 2: hand(s) contacting eye(s)	—	—
A 3: playing own fingers	—	—
B 1: grasp and let go object	—	+
B 2: grasp and keep object	—	+
B 3: mouthing object	—	—
B 4: move object from hand to hand	—	—
B 5: turn object using hands	—	—
B 6: tap object on own body	—	—
B 7: tap object on wall/platform	—	+
B 8: pick up object	—	+
B 9: pick up object just dropped	—	—
C 1: detect of tactile contact of objects	—	+
C 2: recall tactile contact of objects	—	+
C 3: touch walls/ceiling	—	+
C 4: tactile search for dropped object	—	—
C 5: tactile search of details of object	—	—
C 6: tactile search of structure of walls	—	+
C 7: compare tactile experience	—	—
D 1: react to self-produced sound	—	+
D 2: push objects making sound	—	+
D 3: rattle to produce sound	—	+
D 4: grasp just after self-produced sound	—	+
D 5: comprehend self-produced sound	—	+
D 6: compare self-produced sounds	—	+
E 1: play sequence-game with 2 objects	—	+
E 2: play sequence-game, several objects	—	—
E 3: repeat sequence-game	—	+
E 4: quantity-games	—	—
E 5: comparing games	—	—
F 1: control by circular sweep of hand	—	+
F 2: tactile control of position of object	—	—
F 3: comprehend position of specific object	—	+
F 4: compare positions of objects	—	—
G 1: repeat the same activity immediately	—	+
G 2: interrupt activity for few seconds	—	+
Total B-F	0	18

Group ½/8: Case no. 19. Girl, 19 mo. 15 d. Impairments: Optic atrophy, microcephalus, epilepsy, cerebral palsy, mental retardation.

	The Frame	*The little Room*
A 1: mouthing own hand	+	+
A 2: hand(s) contacting eye(s)	—	—
A 3: playing own fingers	+	+
B 1: grasp and let go object	—	+
B 2: grasp and keep object	—	+
B 3: mouthing object	—	—
B 4: move object from hand to hand	—	—
B 5: turn object using hands	—	—
B 6: tap object on own body	—	+
B 7: tap object on wall/platform	—	—
B 8: pick up object	—	—
B 9: pick up object just dropped	—	—
C 1: detect of tactile contact of objects	+	+
C 2: recall tactile contact of objects	—	+
C 3: touch walls/ceiling	—	—
C 4: tactile search for dropped object	—	—
C 5: tactile search of details of object	—	—
C 6: tactile search of structure of walls	—	—
C 7: compare tactile experience	—	—
D 1: react to self-produced sound	+	+
D 2: push objects making sound	+	+
D 3: rattle to produce sound	—	—
D 4: grasp just after self-produced sound	—	+
D 5: comprehend self-produced sound	—	+
D 6: compare self-produced sounds	—	+
E 1: play sequence-game with 2 objects	—	+
E 2: play sequence-game, several objects	—	—
E 3: repeat sequence-game	—	+
E 4: quantity-games	—	—
E 5: comparing games	—	—
F 1: control by circular sweep of hand	—	+
F 2: tactile control of position of object	—	+
F 3: comprehend position of specific object	—	+
F 4: compare positions of objects	—	+
G 1: repeat the same activity immediately	—	+
G 2: interrupt activity for few seconds	+	+
Total B-F	3	16

Table 32

Group ½/8: Case no. 20. Boy, 8 mo. 1 d. Impairments: Retinopathy of prematurity, hydrocephalus. Prematurity: 14 weeks.

	The Frame	*The little Room*
A 1: mouthing own hand	—	—
A 2: hand(s) contacting eye(s)	—	—
A 3: playing own fingers	+	+
B 1: grasp and let go object	+	+
B 2: grasp and keep object	+	+
B 3: mouthing object	—	—
B 4: move object from hand to hand	—	+
B 5: turn object using hands	—	—
B 6: tap object on own body	—	—
B 7: tap object on wall/platform	—	+
B 8: pick up object	—	—
B 9: pick up object just dropped	—	—
C 1: detect of tactile contact of objects	—	+
C 2: recall tactile contact of objects	—	+
C 3: touch walls/ceiling	—	+
C 4: tactile search for dropped object	—	—
C 5: tactile search of details of object	—	+
C 6: tactile search of structure of walls	—	—
C 7: compare tactile experience	—	+
D 1: react to self-produced sound	+	+
D 2: push objects making sound	+	+
D 3: rattle to produce sound	+	+
D 4: grasp just after self-produced sound	—	+
D 5: comprehend self-produced sound	—	+
D 6: compare self-produced sounds	—	+
E 1: play sequence-game with 2 objects	—	+
E 2: play sequence-game, several objects	—	+
E 3: repeat sequence-game	—	+
E 4: quantity-games	—	—
E 5: comparing games	—	+
F 1: control by circular sweep of hand	—	+
F 2: tactile control of position of object	—	+
F 3: comprehend position of specific object	—	+
F 4: compare positions of objects	—	+
G 1: repeat the same activity immediately	—	+
G 2: interrupt activity for few seconds	—	+
Total B-F	5	23

Dansk resumé og konklusion

Undersøgelsens formål

Den foreliggende undersøgelse introduceres dels ved en teoretisk beskrivelse af forskellen mellem seende og blinde spædbørns muligheder for at tilegne sig den første rumforståelse, dels ved en gennemgang af tidligere undersøgelser og observationer af blindfødte småbørns evne til at udføre spatialt relaterede handlinger.

Formålet med undersøgelsen var at observere om et specielt designet eksperimentelt miljø ville befordre tidlig udvikling af forståelse for spatiale relationer hos blindfødte småbørn samt observere, hvilke af miljøets egenskaber der tidligt i det blindfødte barns liv ville virke fremmende for udviklingen af forståelse for spatiale relationer.

Beskrivelse af undersøgelsen

Blindfødte småbørn blev tilbudt materialet »det lille rum«, som er et stel af metalrør med påsatte væg- og loftmoduler. Stellet uden moduler blev benyttet som kontrol-miljø. Både »stellet« og »det lille rum« var ensartet udstyret med genstande, der havde forskellige taktile og auditive egenskaber.

Undersøgelsen omfattede 20 blindfødte børn i alderen 5-19 mdr.; ni af disse blinde børn var også mentalt retarderede.

Børnene blev inddelt i fire grupper med fem børn i hver gruppe. Efter tilfældig udvælgelse blev hvert barn videofilmet i henhold til én af fire forskellige sekvenser. Hver af disse omhandlede otte perioder à 20 minutter, men varierede i antal henholdsvis i »stellet« og »det lille rum«.

Alle de otte perioder, hvert enkelt barn blev filmet, fandt sted inden for 4-5 dage af én uge.

Observation af de oftest forekommende spatialt relaterede handlinger på de i alt 54 timers videofilm dannede grundlag for udarbejdelse af en scoringsliste.

Scoring udførtes for hvert barns handlinger i henholdsvis »stellet« og »det lille rum«. Der scoredes for handlinger inden for det pre-kinestetiske; det taktile og det auditive område, samt for evnen til at lege sekvenslege og for forståelsen af genstandes position. Ligeledes scoredes for øjeblikkelig gentagelse af en aktivitet.

Resultater

Flere ophold i »stellet« førte ikke til fremskridt i udførelse af spatiale handlinger, idet hvert barn allerede i første periode i »stellet« viste sin formåen vedrørende spatialt relaterede handlinger.

Sammenlignet med præstationerne i »stellet«, viste 14 af de 15 børn, der opholdt sig i »det lille rum« i fire, seks og otte perioder à 20 minutter, en gradvis fremgang i udførelse af spatialt relaterede handlinger.

Sekvens-lege og forståelse af genstandes position indtraf kun under ophold i »det lille rum«.

For alle børnene under ét var den forekommende fremgang i spatialt relaterede handlinger signifikant ved p. < 0,6 % (Kendall's test).

Fremgangen inden for det taktile område var næsten den samme hos alle børnene; fire perioder i »det lille rum« var tilstrækkeligt til at opnå dette, mens seks og otte perioder ikke frembragte yderligere fremgang med hensyn til taktil præstation.

Fremgangen i auditivt betingede handlinger resulterede i, at 11 børn lærte, at de selv producerede de genstands-baserede lyde. – Denne viden gjorde disse børn i stand til at lege sekvenslege og til at forstå genstandes position.

Mentalt retarderede blinde børn udviste næsten samme fremgang som dem, der kun var blinde, men de behøvede mere tid i »det lille rum« for at opnå fremgangen.

I »stellet« var drenge ikke så kapable som piger, men ophold i »det lille rum« bevirkede fremgang til tilnærmelsesvis det samme niveau som piger.

De børn, der var yngre end 10 mdr., havde næsten samme fremgang som dem, der var over 10 mdr. gamle.

Børnene viste klart, at de foretrak genstande med særlige egenskaber, såsom genstande hvis overflade havde spidse markeringer, genstande hvis form kunne ændres samt ting, der delvis kunne skilles ad.

Stabiliteten i det eksperimentelle miljø var nødvendig for introduktion af genstands-begreb og forståelse af genstandes position; dette skete i korrelation med taktile og auditive oplevelser.

Analyse og diskussion.

Resultaterne af undersøgelsen viser, at blindfødte børn meget tidligt i livet er i stand til at tilegne sig spatialt relateret viden, hvis de får et særligt miljø.

Forståelsen for spatiale relationer synes at være en udviklingsmæssig proces, der starter med bevidsthed over for taktile og auditive feedback på pre-kinestetiske bevægelser.

Kapacitet inden for det pre-kinestetiske område var en betingelse for fremgang på det taktile og auditive område.

Integration af sanse-modaliteter var en betingelse for fremgang i områderne sekvens-lege og forståelse af genstandes position.

Årsagen til den fremgang, der forekom i »det lille rum«, skyldes sandsynligvis flere faktorer: udelukkelse af lyde fra den omgivende verden, ekkosvar inde i »det lille rum«, tilstedeværelsen af genstande af særlig præference, muligheden for øjeblikkelig gentagelse af en handling, stabiliteten i »det lille rum« og det faktum, at ingen eller intet fra den omgivende verden greb forstyrrende ind i barnets aktiviteter.

Alle disse faktorer førte til en voksende integration af sansemodaliteter og gjorde barnet i stand til at forstå, at det selv producerede genstands-baserede lyde.

»Det lille rum« provokerede ikke til fremskridt i udvikling af evnen til at udføre handlinger med begge hænder ud for kroppens midtlinie. Observationer af nogle af børnenes mislykkede forsøg på at bruge begge hænder samtidig antyder imidlertid, at et andet udstyr af »det lille rum« end det benyttede måske kan fremme en sådan udvikling.

Konklusion og fremtidsperspektiver.

Resultaterne af undersøgelsen underbygger den fremsatte hypotese, at et specielt designet miljø vil fremme forståelsen for spatiale relationer hos blindfødte småbørn.

Effekten af ophold i »det lille rum« understøtter de af andre fremsatte hypoteser såsom, at spatial skelnen er funderet på frivillige bevægelser (Jones, 1975), at opmærksomhed over for genstande omkring én er afhængig af adækvat feedback på præliminære bevægelser (Tobin, 1980), og at forståelse for auditivt

baseret konstans ikke er umulig at opnå for det seks mdr. gamle blinde barn (Warren, 1984).

Resultaterne af den foreliggende undersøgelse angiver, at blindhed i sig selv ikke er en hindring for tidlig udvikling af forståelse for spatiale relationer, når blot det blinde barn får et miljø, der gør det i stand til at opnå den første forståelse af genstands- og permanens-begreb samt kendskab til sig selv som producent af genstandsbaserede lyde. Observationer over en længere periode end én uge er imidlertid nødvendige for at afgøre, hvorvidt den forekommende fremgang i forståelsen for spatiale relationer vil bevirke, at barnet bliver i stand til at række efter en lydgivende genstand, uanset hvor denne forekommer og uanset hvem eller hvad, der frembringer den.

Observationer fra undersøgelsen gav anledning til fremsættelse af forslag til fremtidige undersøgelser som f.eks., hvordan forskellige hånd-, finger- og fodbevægelser influerer på udviklingen af forståelse af spatiale relationer; hvorvidt det præsenterede behov for repetition af handlinger forsvinder, formindskes eller fortsætter; hvilke egenskaber ved genstande, der vil frembringe maksimal opmærksomhed; hvordan yderligere integration af sansemodaliteter forløber; hvorvidt kendskab til sig selv som producent af genstands-baserede lyde vil medføre evne til at række efter en lydgivende genstand tidligere i livet end ved den alder af 10 mdr., som Fraiberg (1977) nævnte; samt hvorvidt særlige forhold er nødvendige for at gøre barnet i stand til at overføre tilegnet forståelse for spatiale relationer fra et miljø til et andet.

Det faktum, at fremgangen forekom inden for 4-5 dage, opponerer mod det af andre fremsatte forslag, at det blinde barn nødvendigvis må have adskillige måneders oplevelser og træning for at blive opmærksom på sine nærmeste omgivelser (Adelson & Fraiberg 1974, Cratty 1971, Drever 1955, Hunter 1964, Jurrmaa 1973). Resultaterne opponerer også mod udsagnet fra Davidson & Nesker Simmons (1984), at udvikling af involveren i miljøet kræver tidlig instruktion og træning af andre.

Resultaterne indikerer, at ligevægt mellem interaktion med andre og situationer, hvor barnet er aktivt uden medvirken af anden person, vil gøre det blindfødte barn i stand til at tilegne sig en referenceramme om spatiale relationer, som vil betyde, at det vil blive

mindre passivt såvel i sine selvaktivitets-situationer som i interaktion med andre.

Resultatet af undersøgelsen foranlediger til fremsættelse af det forslag, at det blindfødte barn, så tidligt i livet som i en alder af 3 mdr., bør have mulighed for at gøre sig bekendt med et specielt miljø som f.eks. »det lille rum«, således at det kan begynde at øve sig i spatialt relaterede handlinger så tidligt i livet som muligt.

Yderligere undersøgelser er imidlertid nødvendige for at afgøre, om ophold i et specielt designet miljø vil give det blinde småbarn en referenceramme vedrørende spatiale relationer, som det kan udnytte i andre omgivelser.

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